

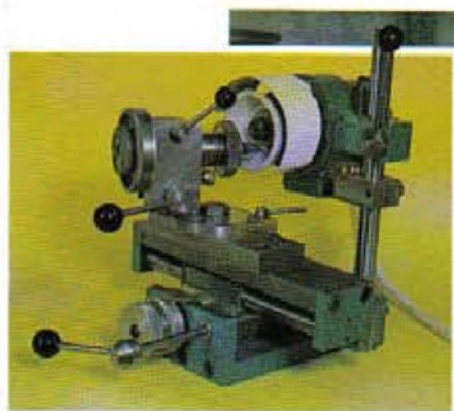
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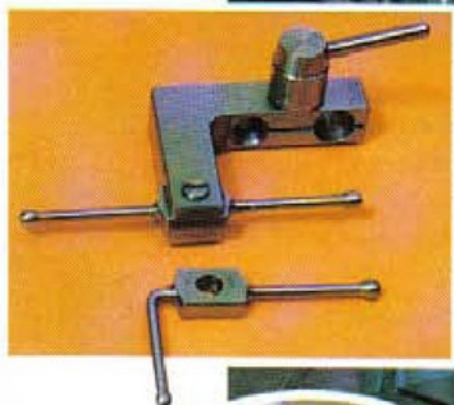
WORKSHOP

THE PRACTICAL HOBBY MAGAZINE



PULLOUT DRAWINGS

A topslide for the Unimat 3



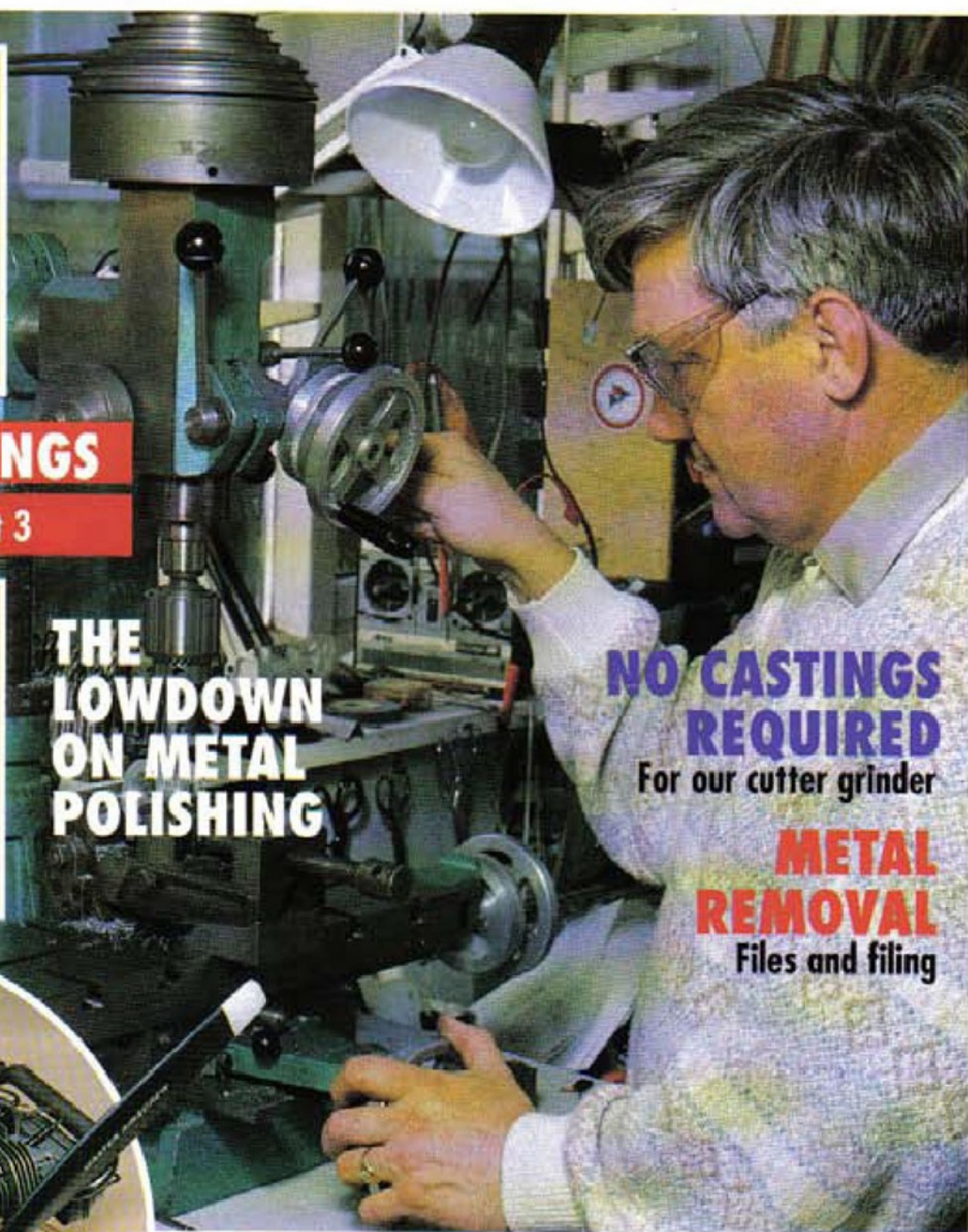
THE LOWDOWN ON METAL POLISHING



MEET AN EXPERT

Derek Brooks: his workshop and models

Workshop equipment at the M.E. Exhibition



NO CASTINGS REQUIRED

For our cutter grinder

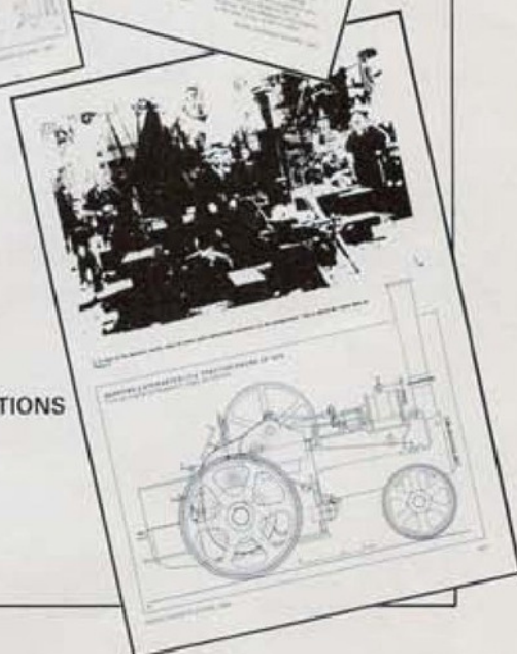
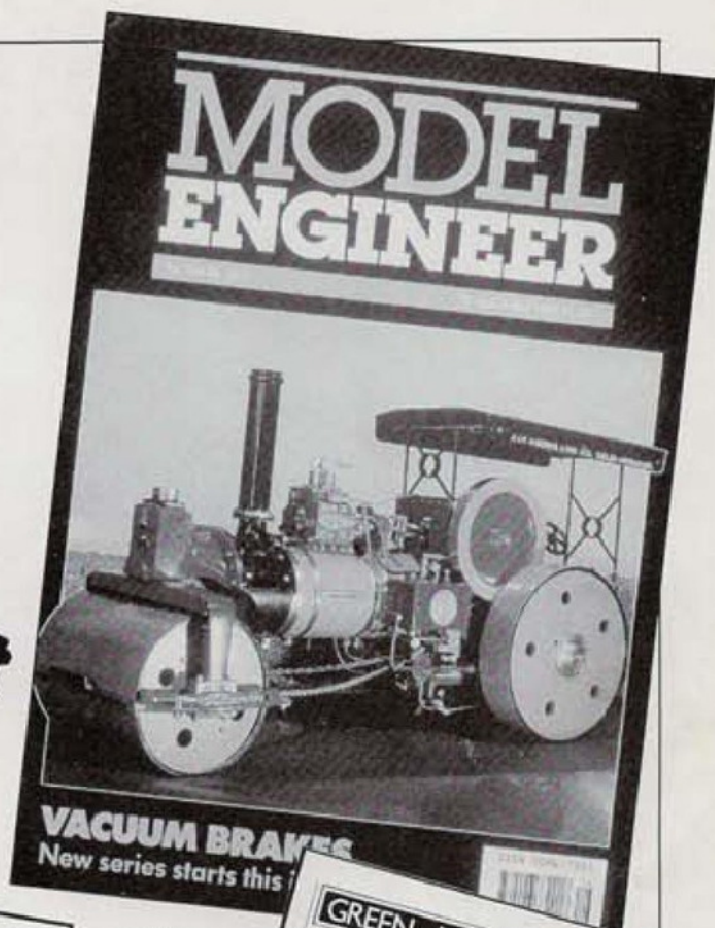
METAL REMOVAL

Files and filing



SOMETHING TO LOOK FORWARD TO...

...every fortnight



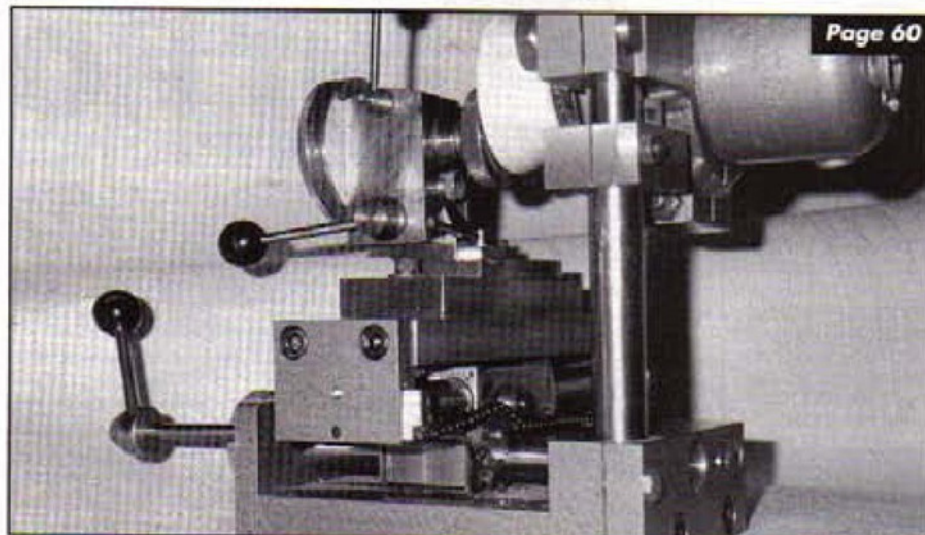
There's something to anticipate twice every month in fascinating Model Engineer magazine! Whether your interests lie in live steam locomotive models, traction engines, internal combustion motors or stationary engines, world famous M.E. will inspire, instruct, advise and encourage. Model Engineer is published on the first and third Fridays each month and costs just £1.40 from all good newsagents; alternatively, you may care to ensure your regular copies through an annual subscription - a mere £33.60 for UK readers (overseas rates and airmail details on request).

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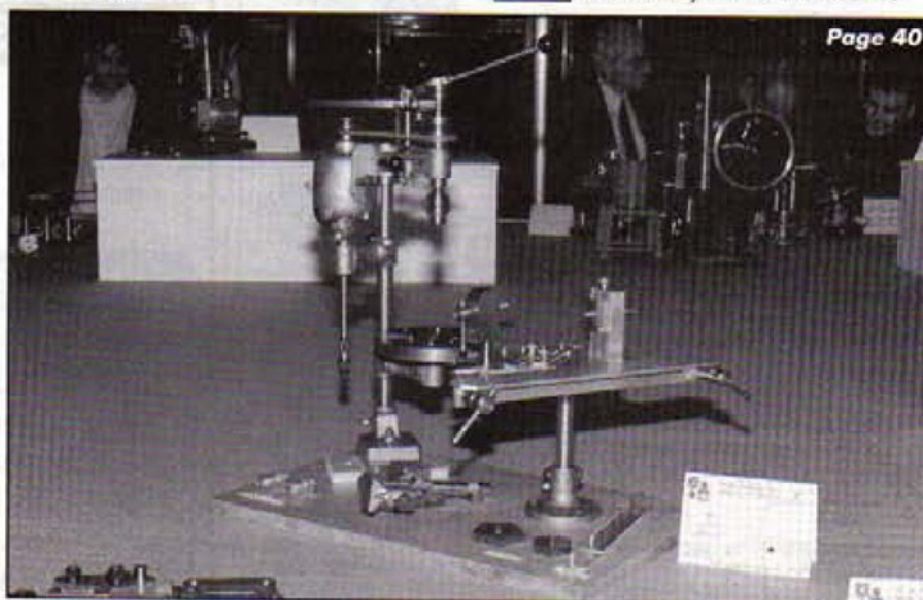
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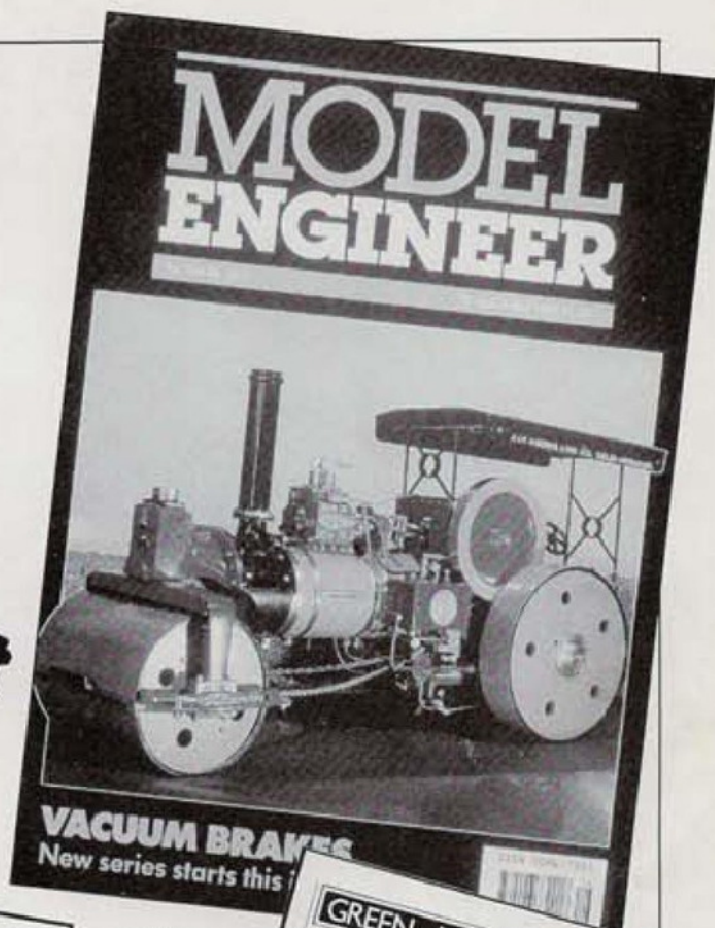


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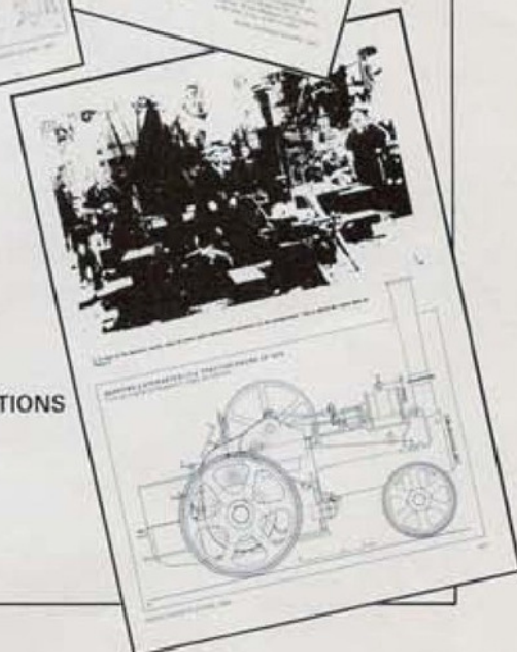
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Harold Hall

ON THE EDITOR'S BENCH

Made to show standards

The International Model Engineer and Modelling exhibition is once more a thing of the past. Visitors will have seen the very fine models of all types and all made to a very high standard. Also on display were a few examples of workshop equipment made to similarly high standards, these have obviously been made initially with the sole desire to obtain the satisfaction of making a quality item, just as one would an engineering model. I feel that it is unlikely, though I am prepared to be corrected, that many of these will not be put to their obvious use, at least until they are a little older in the tooth. I see nothing wrong with this, for if one wants to create some engineering masterpiece then why not a small milling machine rather than the more usual engine of some type? Everyone to their own preference is my motto.

It is true to say however that it is not the purpose of *M.E.W.* to cater for such situations, as helpful as I consider the magazine could be to those with such interests. Perhaps this highlights what I consider to be an essential difference between *M.E.* and *M.E.W.* The model engineer making his model will always, if not with perfection in mind, at least be aiming for a high standard of workmanship; it is right therefore that *Model Engineer* magazine displays that same enthusiasm for quality.

M.E.W. is, as I feel all readers will by now understand, a magazine devoted to providing ideas for usable items of workshop equipment. This does not mean that the satisfaction of a well made item should not be sought, but always bearing in mind the additional time this may take in some, but not all, cases, will keep one from the intended purpose of the workshop. This may be modelling, restoring vintage motor cycles or repairing lawn mowers to name but three interests which I know about.

I have had very few complaints about the content of *M.E.W.* over the last 6 or so issues and even when in issue 12 I prompted readers to send in their views regarding the weaknesses of *M.E.W.*, none were received, other than two who sent in ideas for additional articles. I mention this, because it has been my policy that if all articles had to be of A1 design and presentation then there would only be a few ways of say making a tailstock die holder and a vertical slide and other such items and having published what may be considered the ultimate then that would be

end of story for that item, and *M.E.W.* would soon run out of ideas.

My firm belief though is that even publishing items which may not meet the standard of design that other articles do, the reader, now an author, has made the item and found it useful and hopes that others may also benefit from his experience. Of much greater importance is the fact that ideas published stimulate thought, and as a result readers will place their own personal stamp on items they make from designs taken from the magazine. I get very many letters that support this statement.

Made to be displayed to be used

My rather rambling thoughts above have really been aimed at sounding out readers as to whether they would become involved in an additional display at the next exhibition. The idea I have would be to separate this from the competition tools and thereby avoid the embarrassment of comparison with them. The display could be called such names as "Tried and Tested" or "Made to be used". I am sure some reader will have some better idea. If you have any thoughts on this proposal please do write and let me know them.

D.C. Motors

In the last issue I referred to the technical nature of the two articles to be published on the subject of electric motors, and in particular to that on D.C. motors being published in this issue. I am concerned to know your views, for or against, the publication of such an article in *Model Engineers' Workshop*. So when having read the part in this issue, do please write to me if you consider you have any strong views on their inclusion, against or in favour.

There is of course not much scope for such articles in *M.E.W.* so it is unlikely that similarly complex items will occur that frequently. Of the remaining two parts to the series on speed controllers that on AC speed control in the next issue will be less complex.

In issue 14 on a simple DC speed controller I added a postscript in which I suggested that the motor used by Mr Machin may have been either a permanent magnet motor or a series motor. A small number of readers have written to point out that as the motor is reversing it could not be a series motor, which is of course correct. The fact that only a day or two previously I had written the article on DC motors in which I make just that point makes the error all the more puzzling. In fact I added the note as a last minute afterthought and overlooked that it was being used in a reversing application; I must be more careful.

Book from the past

Two books that I recently had access to made me contemplate a number of letters I have received since taking on this position. These have expressed concern regarding the future supply of professionally trained machinists to our wide ranging hobby. The books in question are machine shop manuals and were published in the early part of the twentieth century. Their content therefore is very much the machining methods of that era. It is true to say however that the processes being described are still very much those of the present day home

workshop. On the other hand, the methods of the modern commercial workshop are much different, with numerically controlled machines and computer aided manufacture, often part of a CAD/CAM, computer aided drawing computer aided manufacture, cycle.

From this it is probably true to say that most commercially trained operators will, in the future, not feel fully at home with the facilities in the home workshop. He or she will never have had to feed the tool to the workpiece by hand and certainly never measured a diameter to determine how much more requires to be removed. I realize this is probably an over statement but without doubt those with intimate knowledge of machining will continue to reduce in number.

Whilst in many things the domestic environment advances apace with the developments of the day, it is inconceivable that our workshops will have the same transformation. So where will the commercially trained and those from other occupations go for their basic machining knowledge? Well it would not be unexpected if I said, this magazine, but to top up that valuable source of gen then why not go to these early books, there were many published for the professional machinist of the day.

Whilst it is not planned to include book reviews in *M.E.W.*, mention of the two that came my way can be found in the trade pages in view of the significance I have seen in them.

Magazines of the past

A reader has sent me some very interesting photocopies from a magazine called *English Mechanics and World of Science*, one of which, dated Oct. 2 1903, and having a number of 1010. The magazine appears to have quite a lot of articles relating to lathes etc in the home machine shop. The reader Mr Gould of Shrewsbury, who suggests that it is the equivalent to an early day *M.E.W.*, would like to know of the date of its commencement and also when it ceased publication.

Similar comments have been received regarding a somewhat later publication, I have some vague recollections of it myself, and that is *Practical Mechanics* by the well known F.J. Camm. Can any reader help with some background to this magazine also, and whether there are any libraries where these magazines can be seen? Do any readers have any copies?

Phone numbers

Could I request that when writing to me you include in your letter your phone number? For simple situations a phone call may cost no more than a letter and can be much less time consuming.

This issue's request for an article

Experience shows that many readers, and myself included, are apprehensive when it comes to the use of gas torches for soldering and welding, also when being used as a means of heating metal for hardening and tempering purposes. Is there any reader with a wealth of knowledge on these subjects, who would be prepared to share it with us in the form of an article? If you feel that you can, do please write first making your offer before starting on the article.

SCRIBE A LINE

Your views, your pages! Your opportunity to make your point, ask the question or simply pass on a snippet of interesting advice to others. Your letters for publication in Model Engineers' Workshop are always welcome

Gear Train 8 T.P.I. Lead Screw					
Pitch Required	Pitch Produced	Stud	Screw	Metric Converter	Speed Reduction
2.0	2.0012	32	60	44/52	-
1.75	1.7463	16	32	40/44	-
1.50	1.5009	16	40	44/52	-
1.25	1.2508	16	48	44/52	-
1.0	1.0006	16	60	44/52	-
0.8	0.7982	32	54	44/56	3
0.75	0.7505	32	40	44/52	4
0.7	0.6985	16	100	32/44	-
0.6	0.6004	16	100	44/52	-
0.5	0.5003	32	60	44/52	4
0.4	0.4002	32	100	44/52	3

Metric threads on an Imperial lathe

Some further comments on the accuracy of metric threads produced on an imperial lathe, this time from R Fuller of South Africa.

In the Oct/Nov issue Mr Wootten asks about the use of American change-wheels to cut metric threads: I have a Clausing lathe - bought second-hand 40 years ago - and the change wheels I got with the lathe were as follows: 16, 32 (2 off), 36, 40, 44, 46, 48, 52, 54, 56, 60, 64 and 100. There are also two double gears, 20/60 and 25/100, for 3:1 and 4:1 speed changing. I enclose a schedule of the arrangement I use to cut metric threads and would explain as follows:

1) What I term the "metric converter" is two change wheels pinned together through the boss, near the bore, with 2 x 4mm pegs. Washers keep them close without clamping them and stop the pegs falling out.

2) In each case, the first of the pair mentioned is driven from the stud gear and the second drives the lead screw.

3) An idler gear may need to be added to span the distance from stud gear to lead screw.

4) In four cases an additional speed change is needed (using the 20/60 - or the 25/100) to slow down the lead screw by a factor of 3 or 4 as shown. On some lathes a special arrangement may have to be made to accommodate this.

5) Although each pitch produced is by no means exact I find them adequate for most purposes, particularly if a lock-nut is used.

6) Many people put the lock nut behind the main nut. This puts the total strain of the load plus the locking force on the few threads inside the lock-nut. If the lock-nut is put on first the total load is taken on the far greater number of threads inside the main nut.

QUICK TIP

When milling cavities using a vertical mill the recesses frequently become obstructed with swarf. A length of rubber or plastic flexible tube, about 4mm in diameter, can be used to blow the swarf away without getting fingers or brushes into risky positions. Make sure the length of tube is long enough for safety, (probably 300mm minimum) and mark one end to ensure the same end is always placed into the mouth, maybe even make a small mouthpiece. If you have no suitable tube in stock the type sold for car windscreen washers is reasonably inexpensive and readily available.

P.G. Langridge

Elliott machines - help needed

Can any reader provide the following details requested by Mr D Lagdon of W Australia.

I have just purchased an Elliott "mini-borer" secondhand from a machine tool dealer. It is in first class condition having had very little use and came with a full set of collets up to 1/4in. diameter. Unfortunately as is often the case, any manuals and instruction books didn't come with it.

I wonder if any of your readers have a similar machine or know of one so that I can arrange for copies of any information available to be copied. Naturally I would be happy to pay for this facility.

The machine serial number is B E C 015266/208 and is fitted with a power down feed. Table size is 16 x 7in. and the "V" belt

drive is arranged to give 11 speeds.

I have tried to get data from the makers, B.E. Elliott Co., but found they had ceased business and their "successors"? Gate International, say they cannot help.

I enjoy M.E.W. very much and with a milling machine now available I feel that a whole new world has opened up before me.

Electric Furnaces

Interested in an electric furnace? Then Denis Paul of Midsomer Norton suggests a book for ideas but also explains the benefits of the Wild Barfield system. Can any reader expand on this idea?

Your Oct/Nov issue had a letter from Mr Pitcher giving, as he said, some 'negative' advice on making electric furnaces. Full DIY details of this subject are in a 70-page paperback A Compact Electric Resistance Furnace by Dave Gingery, available from Camden Books, Rode, Somerset (Tel. 0373 830151) (£6.80 post paid. Ed.). It is written for 110V supply but full detailed calculations are given so this is no problem.

It does not, though, include details of a 'Wild Barfield' system, which I would consider useful and well within the capability of an amateur electrician.

Hardening of carbon steel consists of raising its temperature to its Critical Temperature and then quenching it. This C.T. varies with the carbon content and must be ascertained to better than 10 deg. C for good results. The 'Wild Barfield' system balances two induction coils, one of which is around the furnace - and therefore the workpiece. When the C.T. is achieved the workpiece then naturally becomes non-magnetic and puts the coils out of balance and can be shown on a null-reading galvanometer. (It also works with many alloy steels.)

Thus it works precisely, without the operator needing to know the % carbon, and without needing to measure temperature accurately - almost impossible in the home-shop.

Bending quality brass rod

Richard Gomme of Wendover has problems in obtaining bending quality brass rod, can any reader help?

I'm a very recent newcomer to model engineering and am writing to seek your advice on tracking down specific materials. I'm a regular reader of Model Engineer and also your own magazine Model Engineers' Workshop; other Argus Publications have also been of great help, including the Workshop Practice Series and the Model Engineers Handbook. From your advertisers I've purchased a good range of materials catalogues and price lists.

My current specific problem concerns brass rod 1/4in. diameter. This is readily available from materials catalogues but if a specification is even quoted, only CZ121 is mentioned. I went to the Stoneleigh Exhibition (and thoroughly enjoyed it); unfortunately, the materials suppliers could offer only CZ121 or, in several cases, they didn't even know the spec. of what they were offering. (This is not good. Ed.) Regrettably I can locate none of the model engineering brasses listed briefly in the Model Engineers Handbook (p.96).

Would anyone please give me some guidance on how (or where) to locate, for

example, the range of CZ105-119 brasses listed in the M.E.H. Any advice would be very much appreciated.

Shifting heavy weights and other ideas

K Murray-Taylor refers to the article in issue 4 regarding lifting heavy items and offers his solution.

To lift a heavy lump such as C.J. Austen's milling machine, (Issue 4, p. 49) why not use an engine crane? My local tool hire shop will hire a crane for about £15.00 including a sling with a lift from 510mm - 2m. The crane has castors so it can be wheeled around and the front wheels can run under the bench. The only possible problem is if you have a wooden suspended floor. Check that it will take the load as all the weight rests on four small castors.

I recently borrowed Stationary Steam Engines by Geoffrey Haynes, (Shire Album No. 42, Shire Publishing) at the end of which is a list of engines accessible to the public. The library seems to have bought this book in 1983 but an old list is better than none. Two of those that I would recommend are Sheffield Industrial Museum and East Pool mine.

For a suds pump try an electric windscreen washer from your local car breakers which will only cost a few pounds.

Literary sources

From J. Conway of Orpington. Some advice on suitable books and some suggestions as to how they can be obtained.

Regarding the letter from Mr D. Murphy published in issue 14, December 1992/January 1993, I expect that by now you have been inundated by offers of books, but in case you have not I can recommend Elementary Workshop Calculations, and Senior Workshop Calculations, both by Dr. W.A.J. Chapman.

Also by the same author, but with less emphasis on calculations, are Workshop Technology Vols. 1, 2 and 3. These are a more general survey of workshop processes and machines applicable to manufacturing industry. Current editions of all these books are in metric measurements and all are in print.

They are recognised as the standard work on engineering, and are used by apprentices and engineers throughout industry. Although they are intended for industry they are equally applicable to model engineering.

All five books are published by Edward Arnold Publishers Ltd., 41 Bedford Square, London WC1B 3DQ and are obtainable by mail order from W.G. Foyle Ltd., 119 Charing Cross Road, London WC2H 0DT, and sometimes secondhand from Skools Books Ltd., 15 Sicilian Avenue, London WC1A 2QH.

There are numerous other authors in the same field. All are obtainable from Foyles. They may be able to send you a catalogue. There is also an earlier book in inch units, called Applied Workshop Calculations written by Dr. Chapman. This may now be out of print, I think that it may be the original version of Elementary Workshop Calculations mentioned above, the name having been revised with the change to metric dimensions.

Another similar book is Practical

Some electro-mechanical thoughts

A. Slater of Wollongong, Australia sends this interesting letter.

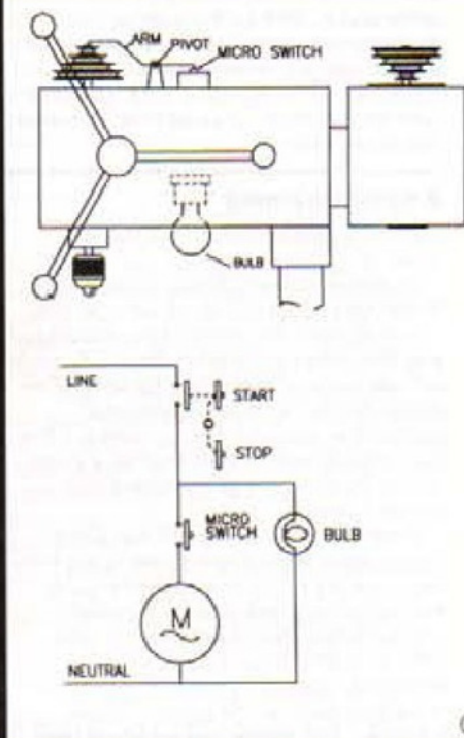
Just a couple of thoughts prompted by previous M.E.W. articles. When selecting secondhand capacitors, as for A Power Hacksaw, great care must be taken to avoid electrolytic or polarised types. These can be identified by +ve -ve markings or a black band around one end. If used on A.C. they are likely to explode violently. They are typically smaller for a given voltage/capacitance range, but only suitable for use on D.C.

The use of earth leakage/residual current-core balance circuit breakers is to be encouraged especially when using power tools. Typically they will detect a current of 30mA flowing to earth and trip in 30msec. However the current flowing through the body, in the case of a fault, is mainly dependent on the total circuit resistance and voltage available. Body resistance is voltage dependent. With sweaty hands, on 230V (over 300V peak), it will be only a few hundred ohms, say 300v/600ohms = 500Ma!!! The ELC/B will not limit the current, only the time it flows, 30ms. In this case it will likely save your life. Though you may bounce off a few walls. Should the current be only around say 20Ma, the ELC/B will not trip and involuntary muscle contraction will prevent one letting go. After only a few seconds cardiac fibrillation may set in and prompt medical attention be required.

Also the ELC/B can be fooled by modern double insulated power tools which have no earth conductor connected to the tool. If the tool becomes wet, falls into a plastic sink, bath etc. or even a cast-iron one with plastic washers under the taps and plastic drains the ELC/B will not trip but the water will become electrified.

As a matter of interest my company had a welder electrocuted recently. The O/C voltage on the machine was only 76 volts, but he was wet from the salt water pipe he was welding. He had just changed the electrode and caught it on his face as he turned back to the job.

I think M.E.W. readers may be interested



in the additions made to my bench drill. I found there was a place, on the underside of the head case, where a lampholder and 60w lamp could be fitted, such that only the end of the lamp is exposed. If not a flexible metal pipe (as found on a bedside light) with a lampholder and small shade fitted, could be installed in a suitable position to light the drill table. Next a micro switch, with shielded terminals was mounted in the belt case between the pulleys. This switch is operated when the quill is fully raised, by a stiff wire pivoting in a small clip. The lamp is connected to light when the start P/B is pressed but the drill will not start until the quill is moved allowing the N/C micro S/W contact to close. This is very convenient when drilling a number of holes, or when the drill grabs and you cannot let go of the drill vice or to stop the drill! The wiring can be fully enclosed in the headcase, and connected as shown.

Workshop Mathematics, illustrated by Professor C.A. Falker, revised by J.L. Thomson M.A. published by Odhams Press. This book is now long out of print and Odhams has ceased business. I got mine secondhand.

For out of print books try TEE Publishing, Edwards Centre, Regent Street, Hinkley, Leicestershire LE10 0BB, England, or Hooreys Book Service, 9 Kings Road, Hastings, Kent TN37 6EA, both of whom operate a book finding service. I have had satisfactory service from both of these companies.

There is in the UK an extensive sub-culture specialising in the finding of out-of-print books, often run by isolated individuals operating as a cottage industry from their spare bedrooms. For more information in this field and names and addresses, get a copy of Exchange and Mart, 42 Mandsley Street, Bolton, Lancashire, BL1 1LF or Books and Magazines Collector, 43-45 St. Mary's Road, Ealing, London W5 5RQ.

Early issues required

James Hotinger of the U.S.A. is yet another reader looking for early issues of M.E.W. Some issues are still available from the back issues department, mostly recent ones. Can anyone help with the problem of removing small screws?

I recently became a subscriber of Model Engineers' Workshop magazine. I found it most useful in the shop and excellent reading as well. I would like to complete my set of M.E.W. If the issues are unavailable from your company, any thoughts as to how I might find the issues I need? I hope you can help.

I also have a technical question: Being rather new to the model engineering field, I am uncertain as to how to extract very small broken screws. The last time I was in England, I purchased a complete boiler, water tank, and stationary engine plant. It was not expensive as parts were missing or broken. As I am restoring this plant, I am at odds as to how I can remove the broken

pieces of the small screws. There are two 8BA screws broken off on a top piece of the boiler and a 10BA on the engine. Any thoughts as to how I might remove them without damaging the threads?

I hope your publication continues for a very long time as it is so helpful. Thanking you in advance.

A timely warning

From T. Greenbaum of the U.S.A. a warning.

In the December/January issue Robin Smith asks about videos as learning aids.

I must warn that some I have purchased and that were produced in the U.S.A. could set instructional video back for years. One group decided against professional production, probably to save money? The one I bought was so bad, both as a video and as instruction that continued sale seems immoral.

Robin Smith is quite right that videos can be a marvellous way to learn, but one must beware of those who always jump into something new to skim the cream.

(Our Reader Services Dept. can now offer an instructional video in colour. Entitled *A Taste of Turning*, it lasts for 60 mins. and features the editor of Model Engineer, Ted Jolliffe, talking about basic lathe techniques, this is aimed at the newcomer. Available for £12.99 inc. p&p and VAT from Reader Services, Argus House, Boundary Way, Hemel Hempstead, Herts. HP2 7ST. Please quote code TVRC39.)

A plea to our suppliers

Don Cottrell from Australia makes this plea to our advertisers. He is not the first overseas reader, and we have quite a number, to make such comments.

Can I make a plea to your advertisers through *Scribe a Line*?

When you place your adverts please advise if you take Visa or any other international credit card. Also do you export?

For many years if I wanted something from the U.K. I had to write over enclosing two IRC's, these cost about £2.75 each over here, then wait for a reply. I would then get a draft and send it over. With two lots of airmail post and two IRC's plus the cost of the draft it was a costly nuisance.

A Model Engineer advertiser advised me to get a Visa card. Our Bankcard isn't acceptable in the U.K. so I got a Visa card issued to me. The world opened up. In a hurry I can ring the U.K. at night (cheap rates) this is your day. Or I can write over. Most times from when I write and order to when I get the items by air is normally ten working days. This is generally twice as fast if I order from some of our local suppliers.

Many times I have written to a U.K. supplier and had their catalogue sent by air, charged to Visa. I have never ordered a catalogue and not ordered something from the catalogue. Why send for it if you don't want something?

My hobby is live steam model boats, there are many items available from the U.K. that you cannot even purchase here. I buy all of my drills, taps, screws, parts for the boats etc. from the U.K. I also buy all of my computer software from the U.K. The Amstrad PCW is not supported anymore in Australia.

A footnote to square holes

As a follow up to our article on drilling square holes, James Yule from Aberdeen sends this interesting article for an 1892 publication. It would appear to say that it can be used to drill round holes of differing sizes with the same drill, obviously with different size templates. Is any reader prepared to give it a try?

As a reader of the old *Practical Mechanics & Model Engineer* since the 30's and not interested in live steam, I was ready for the *Mechanical Engineer's Workshop*. (Should we give it this title? Ed.) I am 86 years of age and enjoy an hour or two in my workshop making tools and gadgets for friends and model makers.

On reading *Scribe a Line* I always go to my *English Mechanic and World Science* Vol. dated 1891-1892 and find that nothing is new to the inventive mind - I can find anything from A-Z *Armateur Lathework* to Zinc blacking. I enclose a copy of an article which appeared in the *English Mechanic and World Science* dated Jan. 15th 1892, of a square drilling machine which Derek Winks explains in his article (issue No. 14), so again we find that we had nothing on the old days when making tools to do the job.

I hope you find the article interesting.

The Square Drilling Machine and its Uses. At an ordinary meeting of the Civil and Mechanical Engineers' Society, a paper on the above subject was read by Mr Reginald Bolton, A.M.I.C.E. The author dealt with certain criticisms that have been applied to the invention, and more particularly with a statement, which he characterised as short-sighted and ignorant, that there exists no demand for such work as the tool accomplishes, and showed diagrams of applications of angular orifices and very clearly demonstrated a number of uses which call for mechanically-formed and correctly-shaped holes. It was further urged that a number of stereotyped devices in mechanical construction are no longer rendered imperative now that it is possible to accomplish by this machine attachments of machinery in a perfectly simple and labour-saving manner. The operation of the tool stands superior to that of hand work by at least a ratio of 36 to 1, and in many cases it will produce results utterly impracticable by present methods at any reasonable cost. A curious point in the invention is that it drills round holes with equal facility to any ordinary boring machine, and is really superior in this respect also, as various sizes may be drilled with the same tool, a perfect adjustment of diameter being provided in the machine. It would seem an almost incredible result, but it is nevertheless a fact, that a taper hole of any shape can be drilled either larger or smaller at the bottom than at the entrance, a capability most important to manufacturers of dies. The square drill thus becomes a tool of almost universal application, and would appear to be a necessary adjunct to any constructive establishment, for it operates equally well in wood, brass and stone. The operation of the machine may be described as that of a rotating drill spindle mounted in a ball joint and vibrated during its rotation against a "firmer" or template giving the desired shape. This template is made adjustable and removable, so that it is a very simple matter to change the work of the tool from a square to flat-sided outlines of many forms. The cutting tool is a one-sided drill bit, containing really one-half of the cutting edge of an ordinary drill.

Drummond lathes

Jim Mander of Brighton shares his experiences in refurbishing a Drummond lathe.

I am writing to you in response to the request by Mr Swingle of Ludlow for information about refurbishing a Drummond lathe in Issue 14 of M.E.W.

I have a Drummond lathe similar to Mr Swingle's and have been slowly restoring it. The cross slide of my lathe had been subject to considerable abuse in the past, so I had a new extended length one made by SJH Engineering, 51 Jessie Road, Aldridge, Walsall, West Midlands, WS9 8HW. They made an extremely good job of it, exactly to the dimensions that I had supplied, so it fitted first time. The proprietor, Mr Hodgetts, is extremely helpful and even sent a photograph of a relatively modern Drummond lathe that belongs to his uncle. I doubt if they would have any trouble making the lead screw described by Mr Swingle. Incidentally, I have found the convenience of the extended length cross slide well worth the extra expense.

Regarding change wheels, my lathe has 14DP gear wheels (with not so much gear teeth as gear tusks!) with $\frac{1}{16}$ in. bore. I don't know if these were the original wheels, but do they seem fairly old. If Mr Swingle has no change wheels at all, I would suggest using Myford gears as I believe they too have a $\frac{1}{16}$ in. bore and with a 20DP they would be a whole lot less cumbersome.

The remaining problem with my lathe is that the tail stock casting is badly worn, giving a great deal of sideways slop with the barrel. The only solution I can think of is to bore it out and fit an internal sleeve. However this would require an accurate tail stock!

Finally, congratulations on a truly splendid magazine. As a newcomer to model engineering I find it a most useful source of information and ideas.

Craft videos

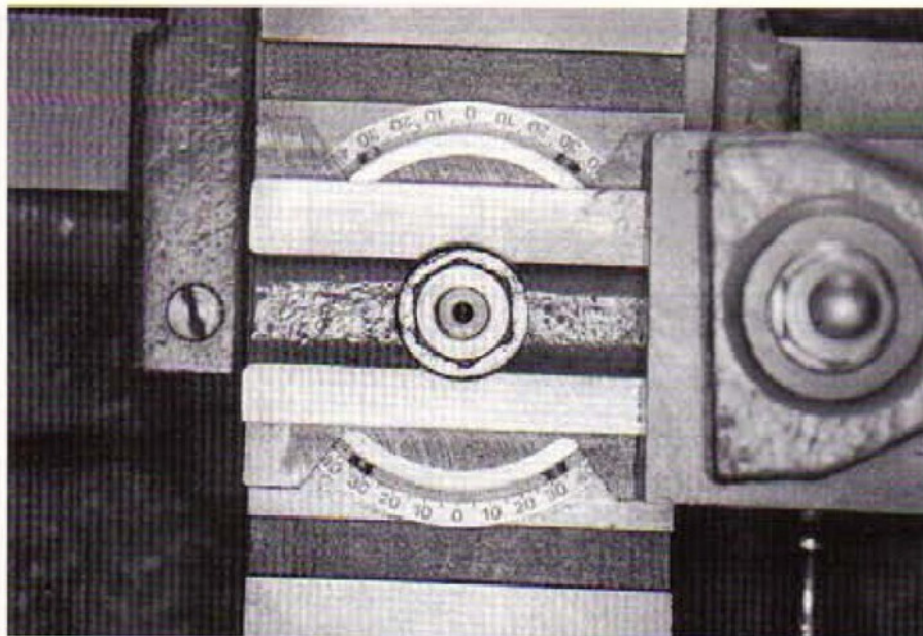
From SPS Audio Visual Ltd. some comments re craft videos. More details to be found in the trade pages.

I refer to the letter in *Scribe a Line* in the December/January issue of the Magazine concerning videos on using lathes, etc. (The letter from Robin Smith of Lynwood, Australia.)

Some time ago we produced a series of short (10/12 minute) videos covering various aspects of Craft, Design & Technology. Initially designed to support the new Standard Grade Curriculum at the time that it was being introduced, these videos have been sold widely in secondary schools throughout the United Kingdom and are still on sale. It might also be of interest to your reader in Australia, that they are now being distributed to schools in New Zealand, and will shortly be marketed in Australia.

I enclose a list of the titles and some other information about the videos. They retail at £7.00 each + VAT and postage. I am sure that Mr Smith, and any other of your readers who are interested, would agree that £7.00 per tape is, in any case, a "reasonable fee".

Not all of our titles would be appropriate for your readers, but I feel, having read the current issue of M.E.W. that most of them would be.



Zyto lathes

Owners of Zyto lathes, and there are some well known model engineers amongst them, will be interested in these ideas sent in by John Richardson of Whaley Bridge. 1) As a relatively new reader of Model Engineers' Workshop, I was very glad to be able to collect some back copies when I visited your offices recently. Thank you!



2) Zyto lathes

Judging by the words 'dealers' have used to describe them to me, I hardly dared acknowledge I had one and thought a Zyto would be far too modest a machine for your publication! Imagine my delight when I saw a photograph of Les May's Zyto on p.32 of your Summer 1990 issue and p.62 of the Winter 1990/91 issue. So here are 4 photographs of 2 modifications and notes on some others I have done with help on my own Zyto no. C.902.

2.1) Change Wheel Divider

The base of the change wheel quadrant was drilled, counter-drilled and tapped $\frac{1}{8}$ in. BSW. The column is a $\frac{1}{2}$ in. dia.x6in. long bar, 0.6in. of which was threaded $\frac{1}{8}$ in. BSW with a nut and washer to prevent it impinging on the leadscrew bearing on which the quadrant is clamped. The detent

block is $\frac{1}{4}$ in. sq.x2.1in. long. It has a $\frac{1}{8}$ in. hole with a slot and clamp screw to fit over the column. A pointed grub screw engages a V-slot in the column to retain its orientation. There are 2 possible positions for the detent (salvaged from elsewhere) to engage a change wheel in the first/simple or second/compound gear train positions. Pointed grub screws engage a V-slot in the spring loaded detent shaft.

Clearly this accessory can be used to achieve a huge number of divisions, but I only know the combinations for 48 (which ends with the detent using every 5th. tooth) and 125 divisions (for a Myford type leadscrew handwheel).

*** Please can someone explain how to find the change wheel/detent combination to achieve any other division. ***

2.2) Top/Tool Slide Protractor

The original pivot lug on the back of the top/tool slide was sawn off and a $\frac{1}{8}$ in. dia. hole bored in the centre of the lower half for a short $\frac{3}{4}$ in. BSF T-bolt with an accurate $\frac{1}{8}$ in. shank and counterbored $\frac{1}{8}$ in. for a tubular spanner and shallow nut.

I photo-etched the 3in. dia. degree rose on $\frac{1}{8}$ in. brass from Letraset transfer LT 195 and vernier degree scales (there's one on the opposite side as well) on thinner brass, quite a process in itself.

Also invisible in my photos is a $\frac{1}{8}$ in.x $\frac{1}{8}$ in. brass bar screwed to the



underside of the rose with 4 screws, the middle $\frac{1}{8}$ in. of which was then removed for a $\frac{1}{8}$ in. hole drilled through the centre of the rose which is a close fit on the T-bolt shank. The bar is a close fit in any T-slot in the cross slide. The centreline of the bar must pass through the centre of the hole but its 90°-90 deg. alignment need not be super-accurate as this can be corrected by adjusting the central index of each vernier scale which has elongated screw holes.

A good friend and accomplished machinist, Bob Harper, did all the machining including the recesses for the vernier scales, processes which I can't describe. Every time I use my lathe I silently thank Bob for his skill and kindness.

I cannot think how this arrangement could be improved and wonder if I could do something similar to my newly acquired 1954 Myford ML7 whose limited top slide rotation seems very inhibited by comparison. Can anyone offer suggestions?

2.3) Zyto C.902's Other Modifications

All the handles and micrometer scales were chromed, but the top slide degree rose described above came later and still needs to be chromed.

A new mandrel was made from high grade steel (a motor car half shaft) with a



Myford thread to reduce overhang with a Myford-Burnard chuck and bored just over $\frac{1}{8}$ in. which increases its through capacity.

The inside shears of the bed were milled to accommodate a Myford fixed steady whose base was modified to suit the Zyto's $\frac{3}{8}$ in. centre height and fit between them.

The original round change wheel studs always rolled out of position and correct mesh when the back nuts were tightened, so I filed the quadrant slides smooth and made new studs with square shanks to slide properly and bite when tightening the back nuts.

Little John lathes

D.K. Jerrard of Exeter seeks help with his automatic centre punch and a Little John lathe, can any reader help?

I have two Eclipse automatic centre punches which when purchased were a joy to use. However over a period of time they have failed to work and although I have dismantled them, I must admit that I have not been able to find the fault, or exactly how they work. Can any reader please offer any advice?

I also have a Little John lathe which is minus the motor, for which I have been unable to get the exact distance from the centre of the drive shaft to the centre of the motor shaft. This machine is fitted with a Vari speed pulley arrangement for which the centre distance is critical. If anyone

could help with this then it would be very much appreciated.

More Drummond lathes

Hugo Kennedy of Clwyd owns two Drummond lathes and is looking for manuals. Can anyone help?

I also have a 3 1/2 in. Drummond Lathe, the same model as Mr Swingle's of Ludlow. It was given to me some 30 years ago complete with original treadle drive with cast iron stand and drip tray but has been modified with a 1/2 HP electric motor since.

The only information I have been able to obtain is a booklet from 'Tee Publishing' on the 'Drummond 3 1/2 in. M Type Lathe 1930'. From the information in the 'Foreword' I assume my lathe was made between 1902 and 1921 as it is round belt driven. After 1921 the headstock was flat belt driven.

I have a set of change wheels, 2 @ 20, 2 @ 30, 1 off each, 35, 38, 40, 45, 50, 55, 60, 65 and these are 14 DP.

I would appreciate a photocopy of the Drummond Manual if any reader could supply one, also I have a Drummond 4 in. Round Bed lathe for which I would like a manual as well.

Dropping Chucks

From correspondence received it is obvious that the problem of chucks dropping out of their Morse taper is not an isolated one. Most have suggested a spot of super glue. Here are three letters, two with a possible remedy and a third from Mike Bolton who may have found the cause.

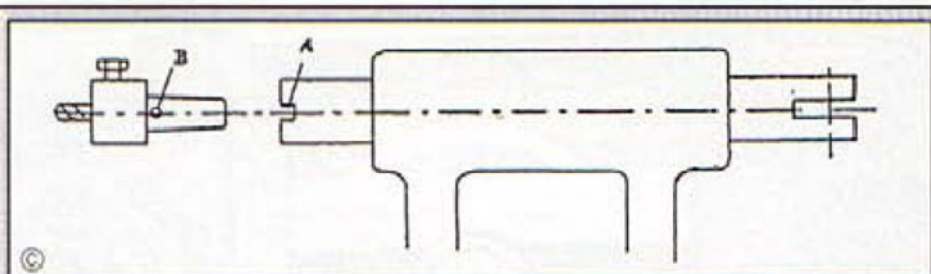
May I say thank you to those readers who kindly took the trouble to respond to my query about square shank drills (Scribe a line Apr/May 92), and to yourself for producing such a rewarding magazine.

In return, may I offer some comments on your letters, first to Mr Ives who has trouble with the chuck dropping out of his bench drill. The same thing happened to me with larger drills, approaching 1/2 in. diameter. The machine has a low speed of 450 rpm and produced a horrible chatter which, I thought, disrupted the fit between the male and female tapers. My drill speed curve gives a speed of about 115 rpm for a 1/2 in. dia. drill in steel so it would seem that 450 rpm is too fast and set up the chatter.

The crunch came when I was using a small (repeat small) grinding wheel in the chuck when it dropped out and went bouncing along the bench. I also needed a new grinding wheel. Urgent and vengeful action followed and I glued it in with Loctite although any anaerobic glue should do. The chuck has never come out since! I didn't in fact, see any reason why I should be likely to want it out.

Second, to Mr Hodgson, who has experienced band saw blade breakages. His Naerok bandsaw is, I believe, similar to a number with different names originating in the Far East and remarkable value for money. I recently bought one because I liked the two-speed facility and the larger table than the one I had before.

I have repaired my own blades with silver solder for some years and then decided to buy saw blade in bulk and make my own. That's when the trouble started, particularly with my new bandsaw. To cut short a long story of trial and tribulation, I have found that my new blade material is too thick. It is 0.025 in. (0.635 mm) whereas



A Fitting Tip

Can any reader provide Derek Walters of Tetbury with the design he is seeking. He also offers some advice re. the compressor article published in issue number 13.

Has any reader a design for a water pump that can be used to remove that dangerous green algae from concrete garden paths, also the salt from the car & just as important wash clean those luscious Jerusalem Artichokes, not to forget grease caked machinery.

I don't think 1000 p.s.i. is necessary. I am sure about 350 p.s.i. is more than enough for that quoted above.

Ref. to M.E.W. No. 13 p.24. 1st. para. - Modern liquid gasket matls.

Perhaps some readers working on overhaul of a compressor or small diesel may wish to know the exact gap between piston head & cylinder head at T.D.C. call it 'X'.

This is easily found by method taught all Army R.E.M.E. V.M's.

Fit new gasket & shims or refit existing if good condition prior to fitting cyl. hd. place a small lead shot dia. 1/16 in. to 1/8 in. on piston head when near D.C. on rising stroke, fit cyl. hd. & torque up the screws or nuts.

Bring piston up smartly over T.D.C. once only, remove cyl. hd. & measure the thickness of the flattened shot.

You now know the exact gap 'X' between piston head & cylinder head.

Do not use aluminium on a compressor or diesel unless specified by manufacturer,

as some materials can "squeeze" with disastrous results to the machine.

This idea from the *Lathe User's Handbook* 1923 has been sent in by M Siddens of Fowey

Useful Makeshifts.

For repetition work, where a capstan lathe is not available, the following plan has been found useful. So useful is it that there is very little difference in the rate of production between it and a capstan.

The sketch shows a lathe which is fixed up for the purpose.

The poppet cylinder has been removed and replaced by a longer shaft to which is attached a hand lever. The forward end of this is bored out to a Morse taper as if to take a centre. Holders for drills, bits, reamers, counterboring cutters, box tools, etc., can be made to fit the Morse taper. The front end of the poppet cylinder should have a groove cut across it, A, and pins, B, should extend from the tool holders which engage loosely in the groove to prevent the holder from turning round. These pins should project farther from the holder than the diameter of the cylinder so that they foul the barrel of the head when the cylinder is brought back. By this means the holder is automatically discharged as the lever is brought back, and as the hand is ready to receive it and replace it with another, very little time is lost. Any number of holders can be used in a set.

it should be 0.015 in. (0.40 mm) and my joints were failing in fatigue. There is clearly a relationship between blade thickness and wheel diameter but I have never seen this stated. Perhaps Mr Hodgson is using the thicker blade. Does anyone want about 60 ft. of 0.025 in. blade 10tpi?

Mr Clarke suggests this effective, if unconventional method of securing a chuck.

Ref dropping chucks, (M.E.W. No. 14). I had the same problem when I bought my machine and solved the problem by a few small spots of super glue put on to the taper and then fitting in the normal way, i.e. as recommended. I did mine 5 years ago and it has not moved since.

The normal method for removal of tapers will still work if required.

From the Rev'd Ronald Hatfull of Stafford.

I had a similar problem to that of reader Terry Ives (M.E.W. No. 14) but found a simple solution.

The taper surfaces of the machine spindle and the chuck were carefully cleaned and the chuck fitted as tightly as possible by hand.

The chuck sleeve was then turned to ensure that the jaws were fully inside the body of the chuck.

The nose of the chuck was then given a sharp and positive tap with a soft hammer - e.g. one with a plastic or leather face - in

line with the spindle. Since then, the chuck has never come adrift.

Mike Bolton from Sale comments on his experiences, some good some bad, in purchasing low cost equipment.

Recently I have bought three items of workshop equipment, one 4 jaw independent chuck and backplate, one engineers' square and a Morse taper chuck arbor. All were from reputable mail order companies.

They have all been of such poor quality and so inaccurate that I have had to send them back (at substantial postage cost). The quality of the chuck completely defied belief. It also did not fit the lathe mandrel. The 'square' was not square (0.005 in. in 6 in.), had concave stock edges (0.003 in. in 3 in.), severe chatter marks on the stock, the blade had edges finished with a coarse file and it claimed to be 'hardened' which it was not. The taper arbor had a 5.5% error in the MT2 section, a 3.3% error in the JT33 section and the two tapers were misaligned axially by 0.005 in. leading to a very visible wobble on the chuck. The arbor easily fell out of the socket and could have been dangerous.

The first and third of these items were marked INDIA. The square was not marked at all but claimed in the advert to comply with BSS939, which it didn't. I suspect, as a professional engineer involved with Quality Assurance at work, that the concepts of 'precision' and 'quality control' are alien in

many parts of the world.

I have also had many very good quality lower cost items from the same suppliers, notably products from Eastern Europe. The problem is there is no way of knowing in advance. However, I have always had my money refunded without question on substandard goods although at some cost in return postage especially as such items are often heavy.

I would be interested to know if other readers have had similar experiences.

Comments

Some comments from Alan Jeeves

Two particular aspects of issue No. 15 caught my interest and prompted me to comment, via Scribe a Line. The subject of my applause is the acknowledgement that some home engineers do actually work in 1 to 1 scale and model engineering is not just confined to miniature mechanisms. It is a privilege to be permitted a glimpse into Albert Wallis's affection for his particular province of engineering, and to see the photographs which testify to his proficiency - the magnificent motorcycles, a couple of generations old.

Further to this, the comment on the Editors Bench about building full sized yachts endorses my view that steam driven scale models are not the only product of the home workshop. The growing interest in different activities will create the demand for more extensive information on methods and materials. One of these materials is going to be stainless steel. There is much to recommend it for the amateur and, if handled properly, can be a great asset. I myself have worked

extensively and successfully with stainless for many years and will be offering a few words of encouragement and data for the editor's kind consideration. Also of interest to would be boat builders could be my article on the polishing of metals (which I believe is coming up soon) (In this issue Ed). It may be possible to lop a few hours off the cosmetic side of making marine fittings. I think on the whole we have a lot to look forward to through the future pages of this magazine.

Electric Motors - AC

Jim Cox author of the book *Electric Motors* points out a silly mistake made in the article on ac motors in the last issue of M.E.W., for which we apologize. Please do amend your copy to avoid confusion when being read in the future. The explanation of the theory was, however, correct.

Electric Motors

The article in the February/March issue of *Model Engineers' Workshop* was a good introduction to this subject but a few typographical errors in the section on three phase motors must have left readers considerably puzzled!

The first sentence of the last paragraph of the centre column on page 20 has Star and Delta transposed - it should read '..... a 415v Star connected motor can be run on a 240v supply if Delta connected.'

Further down in the same paragraph the same transposition occurs - it should read '..... a special low voltage motor or, a Star connected 415v motor re-connected in Delta.'

The final typo is at the end of the third paragraph of column 3. This should read

'Modern motors are frequently sold as being for 380/420v Star connected and 220/240v Delta connected.'

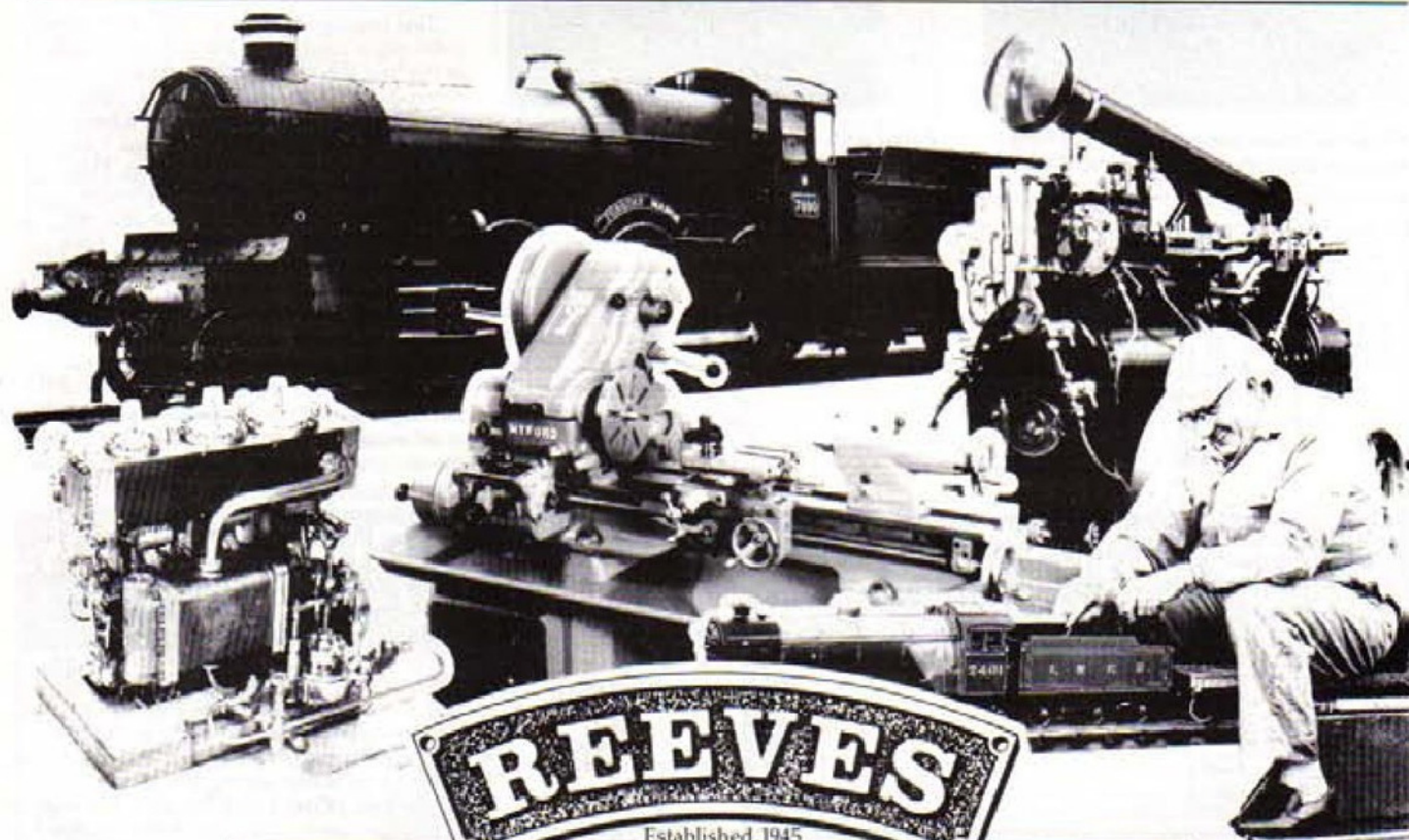
For newcomers to the use of three phase motors it is perhaps more useful to refer directly to the terminal box arrangement. Any reasonably modern (i.e. in the last twenty years!) dual voltage three phase motor will state both voltages on the nameplate and be fitted with a six terminal connection box provided with three loose links.

These terminations are always laid out in two rows of three. Figures 3.3 and 3.4 taken from my book *Electric Motors* show how these links are positioned for the Star and the Delta connection.

A three phase motor purchased new, fitted to a machine or rescued from a scrap yard will almost invariably have the links positioned in the figure 3.3 Star arrangement. This is the 380/415v industrial connection.

For direct operation from 220/240v supplies without the use of special transformers the links should be shifted to the figure 3.4. Delta arrangement.

Operation of these dual voltage three phase motors from 240v single phase supplies is reasonably straightforward. Only few additional components are needed and the home brewed conversion is vastly cheaper than the commercial multi-purpose converters. Both published (*Model Engineer* 20/3/92 and 7/8/92) and unpublished correspondence arising out of the book *Electric Motors* indicates that many home workshop enthusiasts have found this conversion well within their capabilities.



REEVES

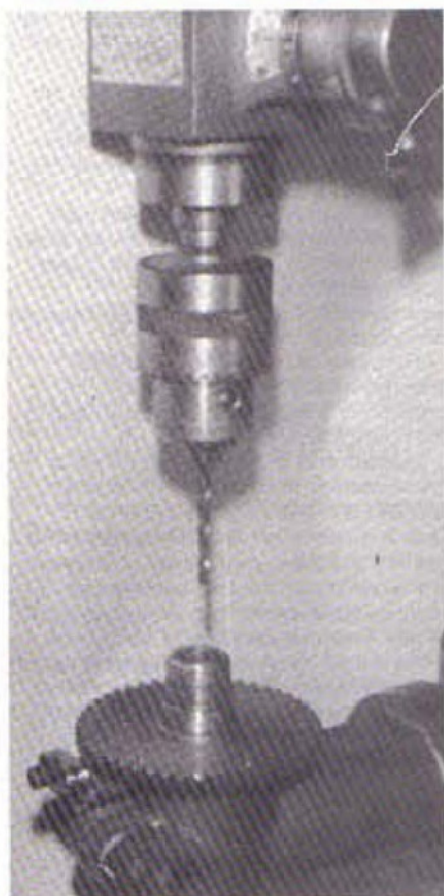
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A DRILLING MACHINE MOUNTED DIVIDING UNIT



The attachment mounted on the drilling machine table carrier, with table removed.



Fitted with the three jaw chuck and being used to make a dividing plate.

Recently I was talked into the task of drilling eight holes of $\frac{1}{16}$ in. dia. at 2 in. P.C.D. in each of 200 plates, each $\frac{1}{16}$ in. thick x 3 in. O.D. This was a daunting prospect without some form of dividing device that was both simple and quick in use. Not wishing to tie up my Myford Super 7B lathe for any length of time I designed and built the device shown.

The unit is based on a redundant 48 tooth gear wheel measuring 4 1/4 in. O.D. x 1/4 in. thick and is capable of divisions of 2, 3, 4, 6, 8, 12, 16 and 24 which I think are probably most commonly required in the home workshop.

The table of my Clarke 5/16-in. capacity drilling machine fits into a socket of 1 1/2-in. dia. and is easily removed, the dividing device is designed to fit into this socket with the table removed. It took very little time to make and has been worth "A pound an ounce" ever since. All the materials came from the proverbial "scrap box", but are of sizes readily and reasonably cheaply available. The dimensions given may require some alteration to suit individual requirements and machines.

If no suitable gear is available then a disc with 48 holes drilled around the edge would make an effective substitute.

The socket (Fig. 1)

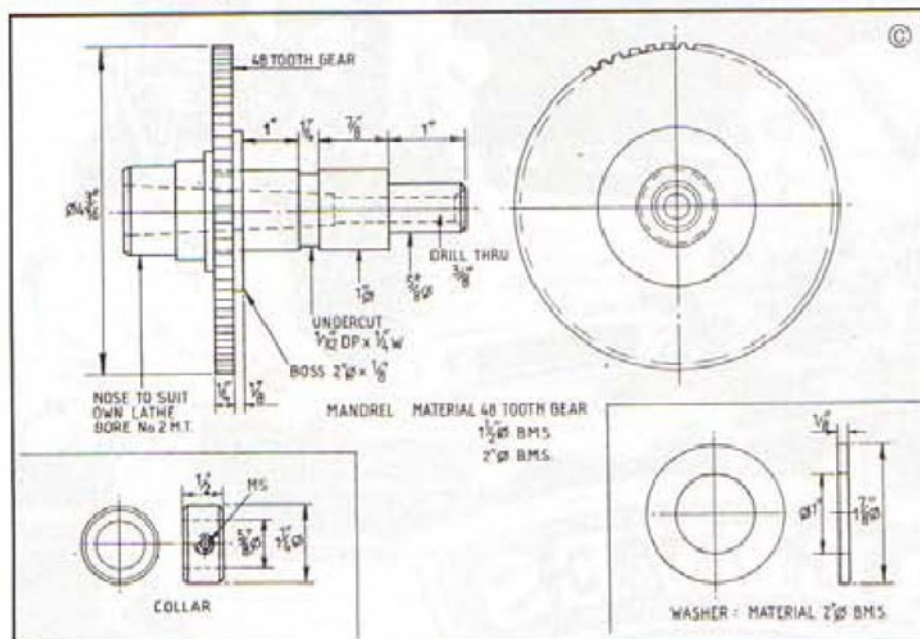
This was turned from a mild steel blank 2 1/4 in. dia. x 2 1/4 in. long. The job was set-up in the four jaw chuck, with sufficient protruding to turn the 1 1/4 in. dia. x 1 1/4 in. long step. This was bored (it could have been reamed), to 1 in. dia. The step, 1 1/4 in. dia was turned at the same setting. This was correct for my machine, it is worth checking your own machine the step will obviously need to be varied to suit. Face off and chamfer this end.

Reverse the job in the chuck and set to run truly, face off this end to finished size plus $\frac{1}{16}$ in. and remove from lathe.

Now, shape a piece of flat steel, in my case 1 in. x $\frac{1}{16}$ in. to match the periphery of the larger end of the socket. The other end is left square. It should be of a length to suit the dividing wheel used, plus an allowance for the detent, which it will carry. This is welded, brazed or silver-soldered into position on the centre line. Replace the job in the chuck; take care for the job will now be out of balance, and face across the whole piece, removing approximately $\frac{1}{2}$ in. to bring it to finished length.

Drill and tap a 1in. length of 3in. square BMS, using any suitable thread, (mine is M6), this block is welded, brazed, silver-soldered or screwed to the end of the 1in. bar, as shown on the drawing. The screw acts as a combined detent and lock.

The final job on the socket is to drill and tap for two grub screws M8 x 120mm and spaced at 120 degrees. These are intended for use in a future attachment.



If you own one of the type of drilling machines with a removable table which is mounted on a central spigot, then this dividing attachment is for you. The design for this simple and effective device has been provided by Kevin Young

The mandrel (Fig. 2)

The blank is set-up in the four jaw chuck, with its outer end supported by the fixed

steady. Face off, centre and drill right through $\frac{3}{8}$ in. dia. With the job still supported by the fixed steady bore for a No. 2 Morse taper. Next turn the outer end to $1\frac{1}{8}$ in. dia. for a distance of $\frac{1}{8}$ in. Do all these operations at the same setting to ensure concentricity. Remove from the chuck.

It should be stressed at this point that the Morse taper is optional, and that the mandrel may if wished be simply centre drilled at each end and turned between centres, an easier and quicker alternative for the less experienced.

Reverse in the chuck and grip by the $1\frac{1}{8}$ in. dia. with the outer end again supported by the fixed steady. This will allow you to face and centre drill the end. You will need to use a large centre drill as you have already drilled through $\frac{3}{8}$ in.

If the Morse taper option is chosen, the next operation will require a Morse taper with a parallel portion enabling it to be gripped in the chuck, with the taper pointing towards the tailstock. You may care to consider turning a double ended taper to fit the mandrel; it is well worth the trouble, a fact that will no doubt be apparent in future projects involving internal Morse tapers.

Remove the steady and remove the blank from the chuck.

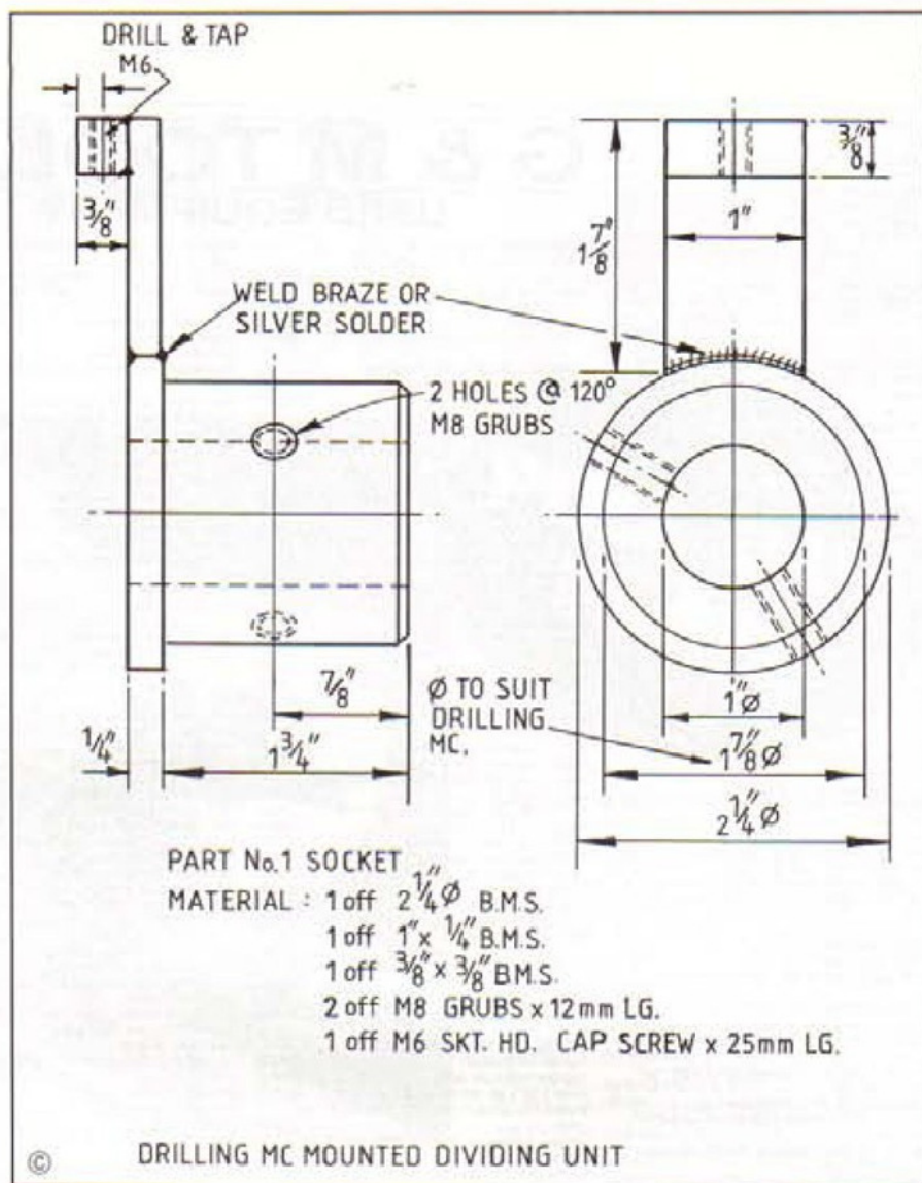
If you have bored the centre for a Morse taper and have a suitable male taper to hand it can now be used as a mandrel. Grip the parallel portion in the chuck, with the taper outwards, slide the blank on to the taper and support the outer end with the tailstock centre. It is now possible to turn the 1in. dia. portion for a distance of $3\frac{1}{4}$ inches. This should be a good shake free fit in the bore of the socket. Next turn the $\frac{3}{8}$ in. dia. for a distance of 1 inch. Turn the relief groove to a depth of $\frac{1}{8}$ in. x $\frac{1}{8}$ in. wide. This groove is there simply to prevent burrs being raised by the locking grub screws.

Reverse the blank and grip on the $\frac{3}{8}$ in. dia., with the other end supported by the tailstock. (I assume that this is with a centred plug in the Morse taper - Ed.) It is then possible to turn and screwcut the nose to match the thread on the nose of your own lathe so that your own chucks can be used.

This completes the turning of the mandrel.

The dividing disc

The disc I used was a 48 tooth gear of $4\frac{1}{2}$ in. dia. x $\frac{1}{8}$ in. thick. This was gripped in the three jaw chuck on the outside



diameter and bored to a press fit on the 1in. dia. of the mandrel. Once fitted to the mandrel the whole was set up to run truly in the lathe and the faces skimmed to the dimensions shown in the drawing. This will of course depend on the size of the gear or disc being used. Final job is to make and fit the 2in. dia. x $\frac{1}{8}$ in. thick boss.

The mandrel can now be removed from the lathe and fitted to the socket using a drop of oil to ensure sweet running.

Final job is to make and fit the washer and collar to the $\frac{1}{8}$ in. diameter. The job is now complete, and you are the proud owner of a cheap, compact and versatile dividing device.

To use

The table is first removed from the drilling machine and replaced by the dividing device which is completed as required by adding chuck, faceplate etc. This enables work already held to maintain concentricity for the second operation, the P.C.D. required is set and the arm is locked in place on the column. The first hole can now be drilled, the dividing disc turned the required number of divisions the second hole drilled and so on until the required number of divisions is reached.

This tool has proved invaluable to me, I hope that it prove to be so for others.

KPL's TOP QUALITY HSS DRILL SETS EXCELLENT VALUE - BRIGHT GROUND FINISH

These superb quality popular Metric and Imperial straight shank drills are seldom found in the UK, as most production goes to the USA. These drill sets are available from **KPL PRECISION**. To order please use the coupon or credit card holders

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ALL MAJOR CREDIT CARDS ACCEPTED

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KEYWARD PRODUCTS LIMITED

226 White Horse Road
Croydon CR0 2LB



Supplied in a strong metal box with self lifting drill holders & size identification!

(13 PIECE SUPPLIED IN A STRONG PLASTIC CLICK SHUT BOX)

**29 PIECE
£20.00
inc. VAT and P&P**

ORDERS DISPATCHED WITHIN 48 HRS

Please send the description of goods in appropriate	Quantity	Unit Price	Total
29 piece Imperial 1/16" to 1/2"		£20.00	
19 piece Metric 1mm to 10mm		£8.00	
13 piece Imperial 1/16" to 1/4"		£4.50	
13 piece Metric 1.5mm to 6.5mm		£4.50	

I enclose a cheque/postal order for GRAND TOTAL £

made payable to **KPL PRECISION** Or please debit my ACCESS, VISA, AMEX, MASTER CARD or OTHERS' account as follows:

CARD No

EXP/DATE

SIGNATURE

TITLE NAME

ADDRESS

TEL (HOME)

POST CODE (WORK)

NO. If the delivery address is different from the card holders account, please enclose the account holders address on a separate piece of paper.

Media Code 1H

LATHES	
Bedford A10 5' x 22", 1ph Fully Toolled	£1600.00
Bedford BUD 5' x 22", 1ph Fully Toolled	£1400.00
Bedford CUD 5' x 22", 1ph Fully Toolled	£1250.00
Bedford A10 4' x 18", 1ph Fully Toolled	£1250.00
Bedford BUD 4' x 18", 1ph Fully Toolled	£850.00
Bedford CUD 4' x 18", 1ph Fully Toolled	£750.00
Bedford Model C 4' x 18", 1ph	£550.00
Smart and Brown Model L, 3ph Tooling	£200.00
Harrison L5, 3ph Tooling	£850.00
Colchester Student 6' x 25", well toolled, 3ph	£1250.00
Colchester Triumph 2000 7 1/2' x 50" Toolled 3ph	£3000.00
Harrison T300 6' x 25", Toolled, immaculate 3ph	£2250.00
Harrison 11", 3ph Fully toolled	£1000.00
Harrison 11", 1ph Fully Toolled	£1200.00
Harrison M300 6' x 25", 3ph, choice of 2	£2225.00
Myford super 78 cabinet stand, O.C.T.P. tooling, immaculate, 1ph	£2750.00
Putra 2", lathe cabinet stand, masses of tooling div head, capstan, collets etc	£2200.00
Colchester Bantam 5' x 20", taper turning, tooling, 1 phase	£1400.00
Harrison M300 6' x 25" 3ph, choice of 2 older machines	£1450.00
Colchester Triumph 7 1/2' x 50" gap bed lathe dual dial, taper turning, tooling, immaculate 3ph	£2550.00
Colchester Chipmaster 5' x 20" Varspeed drive	£2550.00
Putra Bench Lathe, motor drive etc	£250.00
We have in excess of 70 lathes (including wood lathes) currently in stock.	

DRILLING MACHINES	
Richmaster 6 Station turret drill, 3ph	£600.00
Burmond SR2 Radial drill, 3ph	£2500.00
Ormsdon bench drill 2MT, 3ph	£225.00
Meddings articulated arm radial drill, 3ph	£900.00
Harrison union pillar drill, 2MT, 3ph	£175.00
Meddings pillar drill, 3ph	£150.00
Collett progress pillar drill, 3ph	£150.00
Fibco pillar drill, 3ph	£150.00
Obitack high speed Bench Drill, 1ph	£120.00
Pollard high speed Bench Drill, 1ph	£225.00
Pollard pillar drill, 3ph	£75.00
Foco seven eight 3MT pillar drill, 3ph	£600.00
Arlopa 2MT pillar drill, rack on table 3ph	£200.00
Ellett 3MT pillar drill, rack on table 3ph	£325.00
We are able to offer considerable reductions on some Ellett, Pollard, Meddings + Union drills (due to large stocks).	

MILLING MACHINES	
Harrison horizontal mill, 3ph	£450.00
A.E.W. horizon vertical mill, 30Tns, swivel head, 3ph	£1250.00
Ellett Sturdimill 1100 Vertical Mill 40 wt, 3ph	£1450.00
Bridgeport Turret Mill, R8 spindle 3ph	£1650.00
Bridgeport Turret Mill, var speed head power feed, R8, 2ph	£2000.00
3ph, Newell D.R.O.	£3000.00
Beaver 3ph Turret Mill, power feed, 30 int spindle, fixed	£2350.00
Newell D.R.O., 3ph	£550.00
Turn Vertical Mill, 3MT spindle, 3ph	£2500.00
Turn Senior Horizontal, power feed Table 8' x 30"	£2000.00
Turn Senior Horizontal, Turret head, 8' x 30" table, power feed, 3ph, immaculate	£1750.00
Bedford VMCO Vertical mill, 3ph, 30Tns spindle	£1450.00

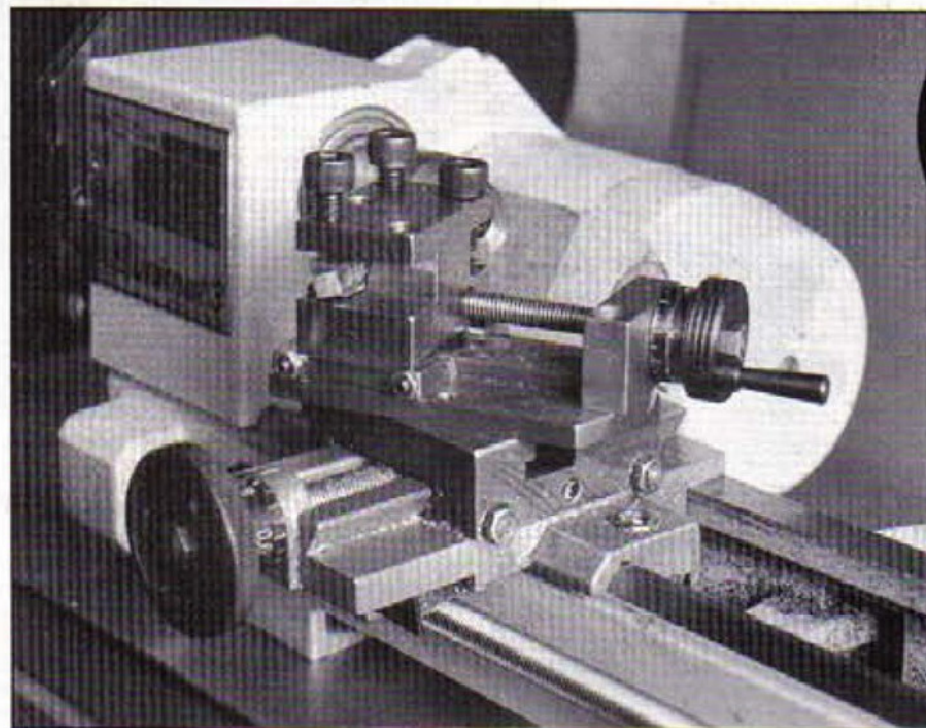
POWER HACKSAWS	
Qualters & Smith 6" 3ph	£225.00
Manchester Rapidor 6", 1ph	£200.00

GRINDERS, UNISHERS, POLISHERS	
Ellett Excess surface grinder, Mag chuck, 3ph	£880.00
Harrison double ended polisher, 3ph	£120.00
Union Jubilee double ended grinder, 3ph	£125.00
Wolf D.E. grinder, 3ph	£45.00
Olva Schultz bench lapidary grinder 1ph	£125.00
Clarkson tool & cutter grinder, toolled, 3ph	£550.00
Eagle surface grinder (old)	£375.00
Bench Unisher 3ph	£150.00

SHAPERS	
Ellett 10M shaper, 3ph	£200.00
Borford 8" shaper, 3ph	£350.00
Astra 6" slotting machine, 3ph	£1250.00
Ellett 18S Shaper with metal vice 3ph	£450.00

BOXFORD SPARES AND TOOLING	
Choxo Gears (also M Southbends) 10B £10, 10B £11, 20B £11, 20B £11, 22B £11, 22B £11, 24B £11, 24B £11, 26B £11, 26B £11, 28B £11, 28B £11, 30B £12, 30B £12, 32B £12, 32B £12, 34B £12, 34B £12, 36B £12, 36B £12, 38B £12, 38B £12, 40B £12, 40B £12, 42B £12, 42B £12, 44B £12, 44B £12, 46B £12, 46B £12, 48B £12, 48B £12, 50B £12, 50B £12, 52B £12, 52B £12, 54B £12, 54B £12, 56B £12, 56B £12, 58B £12, 58B £12, 60B £12, 60B £12, 62B £12, 62B £12, 64B £12, 64B £12, 66B £12, 66B £12, 68B £12, 68B £12, 70B £12, 70B £12, 72B £12, 72B £12, 74B £12, 74B £12, 76B £12, 76B £12, 78B £12, 78B £12, 80B £12, 80B £12, 82B £12, 82B £12, 84B £12, 84B £12, 86B £12, 86B £12, 88B £12, 88B £12, 90B £12, 90B £12, 92B £12, 92B £12, 94B £12, 94B £12, 96B £12, 96B £12, 98B £12, 98B £12, 100B £12, 100B £12, 102B £12, 102B £12, 104B £12, 104B £12, 106B £12, 106B £12, 108B £12, 108B £12, 110B £12, 110B £12, 112B £12, 112B £12, 114B £12, 114B £12, 116B £12, 116B £12, 118B £12, 118B £12, 120B £12, 120B £12, 122B £12, 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UNIMAT 3 TOP SLIDE



The finished top slide mounted and in use.

This little top slide by D. Scroggins uses a novel approach to making the dovetail slides. Intended for use on the Unimat 3, it should not be difficult to adapt the design for use on any other small lathe. Perhaps one could even make a small vertical slide using the same design principles.

I had been rewarded with a pound or two for a small kindness done for a friend, and said that payment was unnecessary, but they insisted that I took the money. As it was earned by using my lathe I decided that it should be spent on tools. A set of five end mills was my goal and these were duly obtained, these had 6mm, 8mm and 10mm shanks. I had always managed gripping them in a drill chuck before, but to obtain greater efficiency from the new tools, I needed to hold them in collets or similar.

If I were to make these myself, some means of taper turning would be required. Finding the price of a top slide too expensive, I decided I would either make one, or forget it. Sketch pad at the ready, a start was made, and it was not long before ideas were forthcoming.

I had visions of manufacturing a dovetail cutter to enable the slideway to progress, but this would take quite a while especially as it was some time since I last made anything similar. This was a problem, and the top slide was put on ice. A day or two later the penny dropped, why not cut the slideway from a piece of hexagonal bar as it would save the laborious task of making a cutter? A proper working drawing was

drafted, and with careful study of the drawing the manufacture of each component mentally gone through, from this I finally concluded that my design could be made on the Unimat 3.

Sharp tools

Before a start is made with the description of the top slide, a word or two on this subject would not be amiss. The majority of components that go towards the make-up of this top slide are manufactured from mild steel. Couple this with the fact that sometimes they border on the limit of the Unimat's capacity, and it is obvious that sharp and correctly ground tools are essential.

I very nearly gave up when I first acquired the Unimat, because of the problems encountered with slip of the driving belts. Now I suffer with black hands and dirty pulleys through using Hoover belts, that are larger in cross section, but still allow standard guards to be used, just. They not only have greater life expectancy, superior drive, and are readily available but, above all else, are much cheaper.

**PULL OUT
PLAN**

Making a start with the base (Item 1)

This component is made from a piece of BMS, 50mm x 6mm x 72mm, the steel is too wide, but we will use this to our advantage later on. It is assumed that the machining required in making the slide will be carried out using only the facilities of the Unimat. This will necessitate some work to be carried out by hand, typically cleaning up one end of the base using a file. Of course, readers having milling facilities with a greater capacity than those on the Unimat can use these.

Mark out as per Fig.2 centre punch and before drilling and tapping check that these line up with the slots in the faceplate. Note that the end nearest to the single hole, on



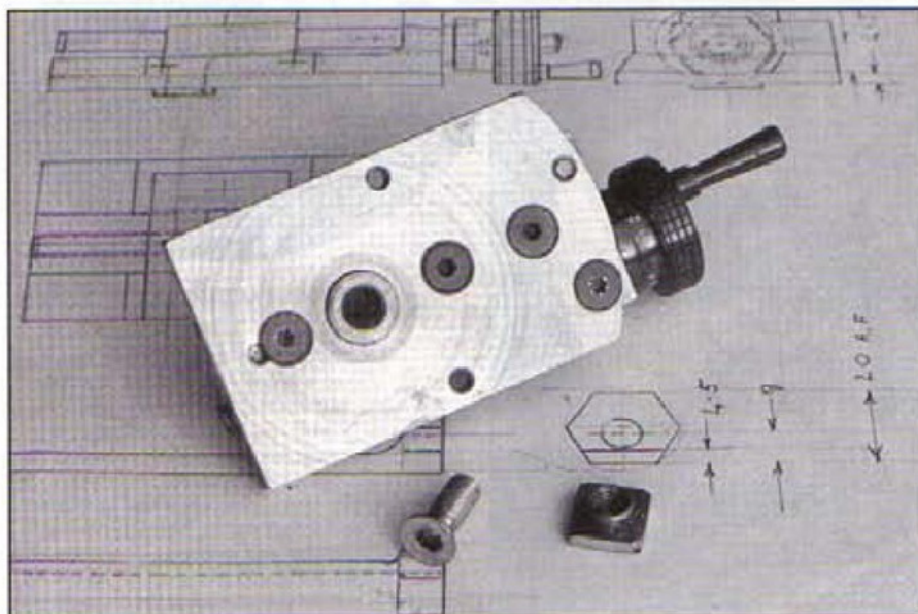
The base mounted on to the face plate ready for machining.

the centre line, is the end just squared up. Fix to the faceplate, allowing the base to extend 10mm at the sawn end. It is now time to machine the underside of the base and create the boss at the same time, use a sharp knife tool with the point of the tool honed to a minute radius. The tool will still be sharp enough to get into the corner of the 10mm boss, and the slight radius honed at the point will provide a decent finish.

Select the slowest speed, touch the tool on to the turning parts, put on a cut of 0.5mm and proceed by using the cross slide (after tightening the saddle) to face the job, but not forgetting the boss which should be left at approximately 12mm at this stage. Stop the lathe and check, thickness of the component, diameter of boss, and finally lay your rule across the

face, just turned, to make sure it is flat. It should be O.K. so continue with the machining until a thickness of 5mm is achieved. Finish off the boss, and with the aid of a centre drill, centre the component, follow this with a 5mm drill, and finish with a 6.5mm drill straight through the boss. Remove from the lathe and, with a fine file, lightly remove the sharp edges caused by the turning operation.

The large radius at the sawn end can now be marked off and filed or machined. I used a file, to give an overall dimension of 70mm. This can now be put to one side whilst the lower slideway is tackled.



View from below base showing machined boss and the various fixings.

The lower slideway (Item 2)

Refer to **Fig. 1**. Select a piece of 19mm A.F. BMS hexagon bar and cut a portion 63mm x 5.5mm thick. Carefully file to an overall length of 61mm ensure the ends are square, not only for cosmetic reasons, but because the bearing block is located at one end of the lower slide.

Attention is turned once more to the base (Item 1). Mark out the position of the four countersunk holes. Take great care in marking the position of the hole, off centre line, this is to secure the bearing block, it also works out very near to the radius. I allowed 8mm dia. for the countersinking. These holes are drilled 4mm diameter. Whilst not that critical, I considered it worthwhile having very little clearance for the screws. The remaining tapped hole is spotted through from the bearing block later. Drill the 4mm holes, followed by countersinking, (same side as the boss), use a 4mm countersunk Allen screw as a depth gauge, the head should be just below the surface.

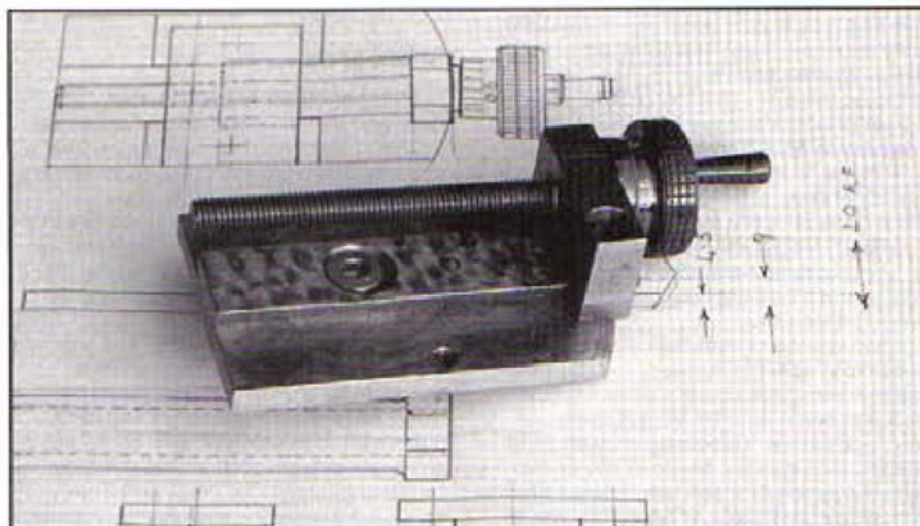
Place the two components together so that the lower slide is resting on the non-boss side of the base, with one of its ends flush with the square end of the base. Clamp the two parts together, using two small clamps applied at either end of the base, leaving all holes exposed for drilling. With 4mm and 6.5mm drills spot through the base into the lower slide, taking the 6.5mm drill completely through. Next drill and tap the three holes M4, and on the widest face countersink to accept an M6 countersunk Allen type screw. Allow for the

fact that the slideway has still to be machined on this face, so extra has to be provided on the depth when countersinking.

Thoroughly deburr the items, and when absolutely sure all burrs have been eliminated they can be assembled. Saw off all the protruding ends of the M4 fastenings. Now is the ideal opportunity to manufacture some Tee nuts (**item 12**) I would recommend at least four.

Machining of the lower slideway to its required thickness can now be done whilst it is fitted to the base. The assembly is held in position on the cross slide by the M6 countersunk Allen screw with the boss

engaging in the recess on the cross slide, a Tee nut holds the assembly firmly in position. When eventually used as a top slide, the boss will allow it to rotate to any angle that we desire to set. Set the machine in the milling mode, secure the base and lower slideway in position, with radius and square end of the base along the axis of the bed. Now machine the lower slideway to a final dimension of 4.5mm above the base. If you do not have milling facilities, then it will be a case of file to thickness or even face the slideway whilst mounted to the faceplate.



Completed base assembly, note the central fixing screw for fixing slide to the cross slide.

The leadscrew support (Item 7)

Take a piece of rectangular BMS, $\frac{1}{4}$ in. x $\frac{1}{4}$ in. would be a suitable size, cut a length 32mm and machine in the four jaw chuck to give the overall dimensions required. Continue by marking the positions of the counterbored and reamed holes, drill, tap and counterbore as required.

Assemble the leadscrew support onto the base with a single M4 screw and lightly clamp in position. Using a 6mm rod through the reamed hole paying particular attention that the rod runs parallel to the slide already fitted to the base. Firmly clamp block on position and spot through the counterbored hole in the support block using a 4mm drill, just sufficient to mark its location. The leadscrew support can now be separated from the base, and the marked position drilled and tapped M4.

The toolholder (Item 8)

25mm square BMS is the material needed for the toolholder, cut a piece 42mm in length, which leaves 1mm each end for cleaning up. Place in the four jaw chuck and face one of the sawn ends, reverse and face the other to give an overall length of 40mm. Those of you without a four jaw chuck will have to resort to filing the ends, you will however have the consolation that practice makes perfect.

Mark the outline of the slot on the three relevant faces, also making an extra centre line for the slot. The slots can be sawn and filed to size, or milled if you have milling facilities on your Unimat in either case, drilling holes along the length of the slot leaves less material to be cut away. This will make the task easier and, as a result, speed up the process. Mark the positions of these holes 4.5mm from the appropriate edges and centre punch. The location of these holes is quite important, so it would be well worthwhile starting them off with a centre drill. Follow up with a 5mm drill and finish with one of 8.5mm diameter. Now complete the slots either by sawing and filing or by milling.

Whether filed or milled, the corners and edges of the slots will have to be carefully removed with a fine file. Just as a matter of interest I have a small Swiss file which is kept solely for the purpose of deburring.

Mark the position of the five M6 holes for the tool retaining screws. With these holes clearly marked, start by centre

drilling all five, then a tapping size, before the holes are actually tapped. Normally I remove the first two or so threads with a slightly larger drill than the actual thread, but as the thickness of the piece is only 5mm, to reduce this further, say to 3mm, would not be a good idea. Lightly countersink them instead, just sufficient to remove the sharp edges and still show slight evidence of chamfering after tapping. The remaining holes are added later.



Toolholder assembly with gib strip.

The upper slideways (Items 3 & 4)

The upper slideways are the next items to be manufactured. As can be seen from the drawings, the difference between the two is that one is narrower and has two M3 holes for the gib strip adjustment, the countersunk holes on the underside are also spaced differently. This is deliberate so that they will fit the assembly only one way.

The overall length is given in Fig.1. A start is made by carefully marking out as drawn and cutting one long slice 6mm thick, if you are not confident about sawing to the line, it can be cut a little thicker. Both of the upper slideways are going to be machined together, in one continuous strip, then divorced from each other. Mark out the components, noting that each individual slide is cut from each end of the strip, drill and countersink as per drawing.

To hold the workpiece for the milling, or even filing, operation, chose a piece of BMS that is nice and flat and drill two holes to accommodate 6mm countersunk Allen type screws, see Fig.3. Then, mark through the one piece upper slideway and tap M4. Assemble the slideway onto the carrier and the two onto the Unimat cross slide, see Fig.3, this is the time to use the extra Tee nuts. Fit the machine with an end mill, or fly cutter, in the vertical milling attachment, lock all the unused slides, and machine to 5mm thick. Note these are similar to their opposite numbers, the lower slideways, in that they are only machined on the countersunk face.

Cut the piece in two, both 33mm from each end of the parent stock. I have allowed 1mm for squaring and cleaning of the ends. This however is not critical as the length of the component does not play an important role in the functioning of the top slide. These items are filed or milled to their finished length of 32mm.

The narrower slideway is machined to 12mm wide, and the position of the M3 holes marked and centred. Drill and relieve the holes on the non-sloping edge, tap, and deburr. Be especially careful over this as they require to be central, there is very little

margin for error. Also when the hole is spotted through to indent on the gib strip, these must be nicely in the middle of the strip to ensure that it will press squarely onto the lower slide.

Toolholder assembly

With these two parts finished the time has come to assembly one onto the toolholder. Position the upper slideway, item 3, onto the toolholder, paying particular attention to it being correctly placed in all respects, clamp the parts together. The holes for the mounting screws can be spotted through using a 4mm drill. The drill is now exchanged for one of the correct tapping size, which can be allowed to pass right through into the slot, finish by tapping holes M4.

If a clamp is not available which is small enough to allow both holes to be drilled at the same setting, first drill and tap one. This tapped hole can then be used to clamp the parts together, for the purpose of repeating the operation on the second of the holes.

Gib strip (item 5)

Before attempting to fit the other slideway make the gib strip, rather than search for a piece of suitable packing. Allowing for the fact that the two sides of the gib strip are at an angle, leave plenty of material on the overall width for this very reason. Acquire a piece of brass about 9mm wide x 2mm thick x 33mm long.

Hold it lengthwise in the vice supported on one side by the angle of the upper slide and on the other by a small section of 3mm round stock, it may be necessary to hire a spare pair of hands to tighten the vice. Allow it to take a position that will permit work to be carried out on the angled edge without any obstruction. Using a fine file create the first angle then turn the component so that it is possible to perform the same operation on the other edge. Carefully remove the surplus until the gib strip will be a snug fit, patience will be rewarded by the fit. Trim to length and deburr, that is another part successfully completed, except for two small dimples to take the end of the adjusting screws, these will be made later.

Now cut a piece of stout card, (post card will suffice), of similar size to the gib strip and a second piece of similar size to the upper slideway. Place the gib strip with cardboard packer followed by the lower slideway, with card beneath, followed by the remaining loose slideway, onto the toolholder with first slideway already fitted. Clamp the lower slideway onto the toolholder and spot through, followed by drilling and tapping as before, finally fix the slideway.

The toolholder assembly is fitted into position on the base, and the complete assembly clamped to an angle bracket with the gib strip securing grub screw uppermost. Fit only one of the two grub screws ensuring that the gib is correctly placed, prevent the toolholder and gib strip from moving by tightening the grub screw. Using the tapping size drill, dimple the position of the screw onto the gib strip, just deep enough to imprison it from any unwanted movement when the grub screw is fitted. Fit a grub screw into the position just used and tighten, remove the original grub screw and dimple in the same way.

Dismantle the assembly and clean thoroughly, removing all swarf from all the

faces including the inside of the grub screw holes. Reassembly leaving the grub screws just tight enough to allow the toolholder to slide along the base. Traverse it along the base towards the radius end and, when it reaches a position about 6mm from the leadscrew block, tighten the screws reasonably hard to prevent any further movement of the assembly whilst drilling for the leadscrew which is to be the next operation.

For the slide to function satisfactorily it is essential that the tapped hole for the leadscrew in the toolholder, is both in line with the hole in the end bracket, and also running exactly parallel with the slide movement. To achieve this, set up the assembly onto an angle plate with the lower end of the assembly on a surface plate and with the leadscrew support facing upwards.

Lightly clamp, and with your most accurate try square, square up the assembly tightening the clamp fully, and to make doubly sure that it cannot move, fit another clamp.

Take the assembly to the drilling machine and using a 6mm drill carefully spot through the reamed hole in the bearing bracket onto the toolholder. In this case, however, the 6mm drill can beneficially be taken up to 10mm into the toolholder to limit the depth of thread to around 15mm, it will also help considerably in ensuring the tapped hole is eventually correctly aligned. Now drill completely through using an M6 tapping size drill.

Dismantle the toolholder with slideways from the base and tap the hole for the leadscrew M6, to ensure correct alignment approach the hole to be tapped through the 6mm hole drilled at the bearing end of the toolholder. Return the toolholder and upper slideways to the base for the time being.

Earlier in this text, I stated that we could turn to our advantage the fact that the base was too wide. By having the upper slideways assembled to the base as instructed, it is now possible to transfer the width of the upper slides exactly, by scribing around the components. With this done, it is a matter of removing the toolholder assembly and filing the base to the lines.

QUICK TIP

When drilling and tapping a machined surface I find it an advantage to pilot the hole. Then prior to opening out to the required tapping size, drill each hole out to clearance size for the thread. Do this to a depth of about 1mm to 2mm, then open out to the tapping size and tap the hole.

This is a time saver when working ductile metals such as mild steel, as it saves having to file off, or even scrape if a precision item, the slight raised portion that results. It also prevents the razor sharp edge at the start of the first thread.

A good example of this would be the plate on page 26 of issue 15 seen as part of Mr E.G. Hartwell's very interesting Cross Vice/vertical slide conversion.

M.E. Stevenson

The bush (Item 9)

The bush was originally made from brass but has now been replaced by one made from cast iron. Initially when making this part I came across a portion of brass, and this was used. The top slide has had much use since then, and I am pleased to report that it is standing up to the usage that it has been put to very well indeed, except for the bush which showed signs of wear. So in an effort to reduce this wear I have since changed it using a piece of cast iron. *(I consider a larger flange on the leadscrew would be helpful. Ed.)*

Making the bush is quite straightforward, but take note, the bore and outer 7mm diameter must be machined at the same setting, as it is essential they are concentric. It is my preference that the bush should be a slight interference fit into the leadscrew support, as I don't like to resort to Loctite, only using it in emergencies. *(Is this an outdated approach, what do you, the readers, think? Ed.)* The bore that locates the leadscrew was reamed 4mm, the part then removed from the small machine, cut off a little over length, replaced in the lathe, and faced to the final dimension.

Leadscrew (Item 8)

The leadscrew is the cause of bitter disappointment as far as I am concerned, in that it should have been left handed. I could not justify the expense of buying a suitable tap to enable me to carry out the job, so I accepted that, for the time being at any rate, a normal right hand variety will have to suffice. Perhaps the opportunity will present itself at a later date when the leadscrew can be remade, then it will not be necessary to wind the handle in reverse. This point must be remembered when it comes to stamping the graduations on the handwheel. If, however, you have access to left handed taps and dies, you should use these.

A piece of MS studding is used to form the basis of this component. The turning is straightforward, the threaded portion should be protected at all times while the part is held in the lathe. Make the M4 thread with a suitable die, then the 4mm diameter, this needs to be a close, but running fit, in the cast iron bush.

Modified M6 cap head screws (Item 13)

Five off these items are required, modify them by turning off the ends of the threaded portion as per drawing. This will prevent them from "mushrooming" and making removal difficult.

The handwheel (Item 10)

For this a piece of 25mm dia. BMS was chosen, an important reason for this choice was that the finished part had to look professional. So after the handwheel had been made it was highly polished and blued, finally the engravings picked out with white paint. The resulting handwheel does not look out of place alongside the original Unimat handwheels.

Place a suitable length of material, being 35mm, in the three jaw, pushing it against the face, machine the end, then reverse in the chuck ready for machining the complete handwheel at one setting. At this point about 25mm should be protruding enabling the shape to be completed at one setting. Turn the reduced diameter followed by the

recess, also a truing cut taken over the 25mm dia., continue this cut, as near as one's nerve will allow, to the chuck jaws without cutting into them. Also drill and tap the M4 hole at this stage to ensure concentricity.

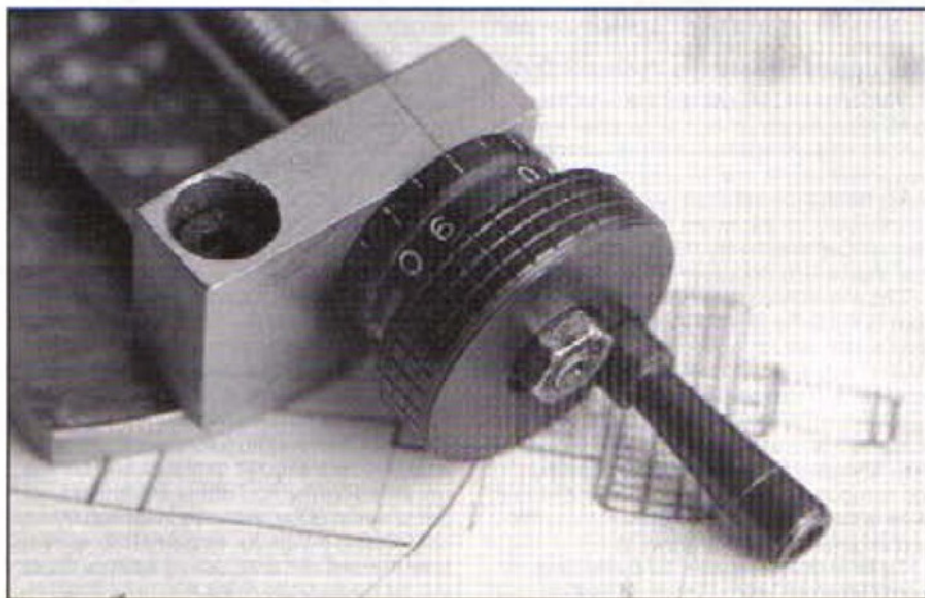
Change the tool for a pointed variety e.g. a screw cutting tool would ideally fit the bill. A series of radial grooves to a depth of 0.2mm should then be cut, starting at 1mm in from the end of the handwheel. Before withdrawing, take a note of the cross slide dial reading so that the remaining grooves can be cut to the same depth.

Repeat this operation until the grooves have reached 8mm along the surface of the handwheel grip, however make this the final ring 0.5mm, that is deeper than the previous ones. Whilst the tool is in this position make also the radial ring required as part of the calibrations. At this stage of the proceedings the little lathe should be set up with a 40 division plate replacing the drive pulley. I chose to use alternate holes (20 giving a pleasing effect). The lathe tool is reset on its side so that it will cut when wound towards the chuck, a detent is set to engage in the circle of 40 holes on the division plate.

similar. Clamp a piece of suitable metal across the lathe bed to limit the travel of the saddle so as to ensure a constant line length of 3mm. The tool is already in the correct position, so proceed to make the ten division lines as follows.

Traverse the tool across the item until it shows slight evidence of making contact, wind tool clear and wind it in 0.15mm, carefully, but smartly, take it up to the preset stop, wind the tool clear, index to the next chalk mark and so forth until all ten divisions have been made.

The shorter of the lines are now engraved. The detent position will almost take care of itself, because it will only be necessary to engage it in the positions on the division plate that are unmarked. Now reposition the temporary saddle so that it is only 2mm in from the beginning of the workpiece, but do make sure this coincides with the radial groove already made at the 2mm position. Finish the markings by making the three intermediate lines between the major divisions in the same manner as those already made. Remove from the lathe and cut the handwheel to just over 14mm in length, using a hacksaw, then return to the lathe and face to a length of 14mm.



Close-up of the handwheel and leadscrew support, note the index line on the leadscrew support, this is not mentioned in the text.

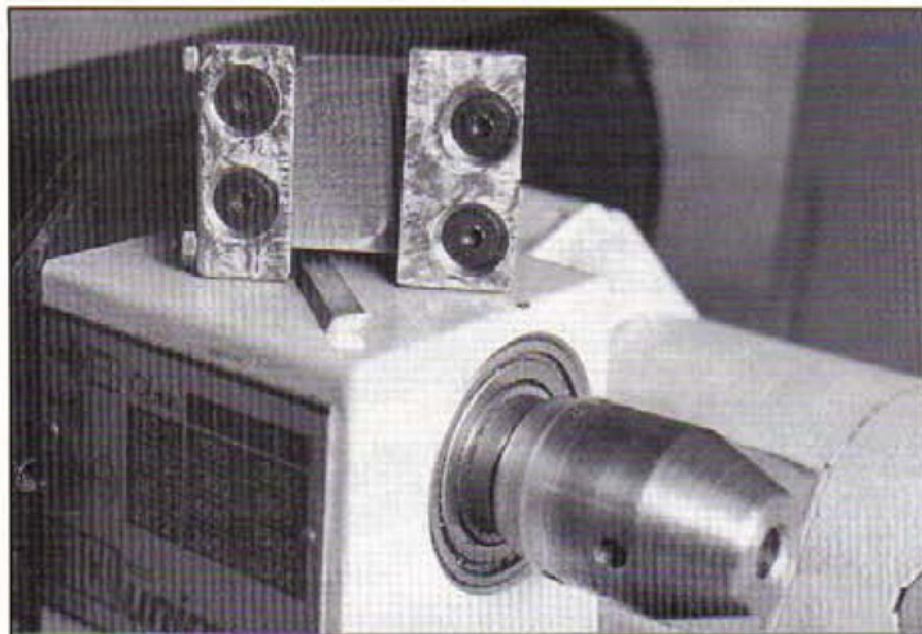
Touch the tool onto the outer diameter and then with the tool moved away from the handwheel advance the position of the tool by 0.15mm. Make sure that the detent is located in one of the twenty holes, and wind the tool across the job until it runs into the deeper groove that has already been made for that very purpose.

Having completed the first line wind the tool clear of the work by using the saddle handle, rotate the item and re-engage the detent in the next appropriate hole. Continue until all of the twenty lines have been made. This method of making a grip on the outer rim of the handwheel places much less strain on a small lathe than the more conventional knurling. The details of this are not shown on the drawings but the result can clearly be seen in a number of photographs.

The next piece of engraving is that for the dial graduations. For the ten division lines that are marked 0, 01, 02 etc. use the same division plate and mark every fourth hole on the plate using a piece of chalk or

The numbers are made using 1.5mm metal stamps and a temporary fixture to accommodate this operation. Rest the item in a small Vee block and clamp the part to a piece of scrap angle iron with the face of the work housing the recess clamped against it. It is a fairly easy matter from here on, as it is possible to rest the stamp against the lip formed by the handwheel end of the handle, taking care that the stamp is held upright, smite with a hammer.

Try to achieve the stamping all to the same depth and positioned regularly, as nothing looks worse than uneven stamping. Hammer strikes all being of about the same force should take care of the first, holding the stamp against the rim of the work should take care of their placing. The only work required prior to finishing is to drill and tap for the handle. With this done, it remains to polish it to a fine finish on the lathe, finishing with a piece of wet and dry. Then, without touching it, heat and quench in oil. Finally fill in the stamping with white paint.



Lower view of toolholder with slideways, showing also the milling cutter holder mounted on to the lathe, making this item being the reason for the top slide having originally been conceived.

Finishing

The topmost face of the base, the uppermost face of the lower slideway and the faces incorporating the countersunk holes of the two upper slideways, were given a mottled effect with a small hand scraper prior to final assembly. This was more for swank rather than for precision. A splash of oil on all of the parts and then they were put together.

The leadscrew and handwheel are loosely assembled and the locknut is left loose, adjust to give a free fit with no detectable backlash, then fully tighten the M4 nut. Also when fitting the gib strip the two adjustment screws are brought lightly to bear upon the gib and then tightened equally until they begin to bite, test the action of the top slide and it should feel firm but no tightness. Finish off the

assembly by the addition of two locking nuts on the gib adjusting screws and tighten fully, check that it is still in correct adjustment.

Handle (Item 11)

Observant readers will have noted that the top slide is not yet complete, the handle has still to be made. As we are now the proud owner of an almost complete taper turning top slide, it can be tried on the manufacture of the handle. It is just a matter of fitting up our little workhorse for turning once more and the best of luck, you should be well rewarded for your efforts. I nearly forgot why I made this tooling, it turned the tapers on the milling tool holders a treat.

P.S. Don't forget to polish and blue the handle to match the handwheel.



QUICK TIP

For cross drilling shafts make a single sided vee block by clamping the material in the tool post, or four way turret. If you do not have a proper vee cutter, make a line of overlapping centre drill holes followed by finishing off slowly with a HSS countersink drill. Mark the top of the block to avoid using it the wrong way up. Your cross holes can then be drilled, even at an angle if required by just swivelling the top slide and centre drilling gently to get the hole started.

Colin Porter

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THEY INVENTED MACHINE TOOLS!

ENGLISH AND AMERICAN TOOL BUILDERS

(originally published in 1916-reprinted by Lindsay Publications)

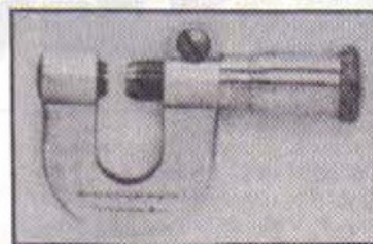


Maybe you can use a lathe and a milling machine. But did you build your own? Do you know who built the first such machine tools?

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Also covered are fascinating details of the careers and the inventions of Joseph Whitworth, Eli Whitney, Blanchard and his gun stocking lathe, Samuel Colt and his armoury, Root's chucking lathe, Francis Pratt, Amos Whitney, Frederick Howe, James Hartness, and others. These are the men who took the lathe and used it to pioneer mass production.



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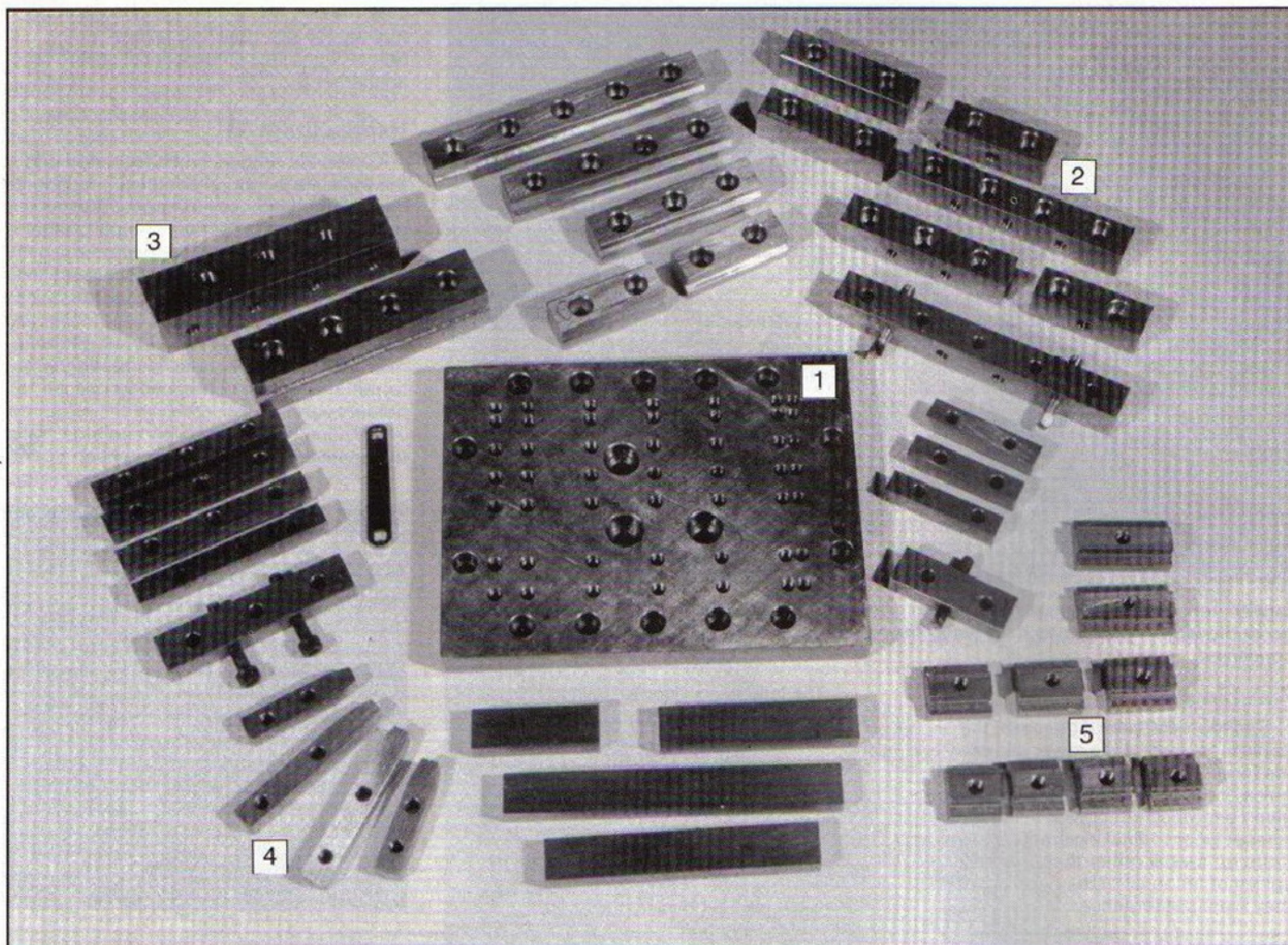
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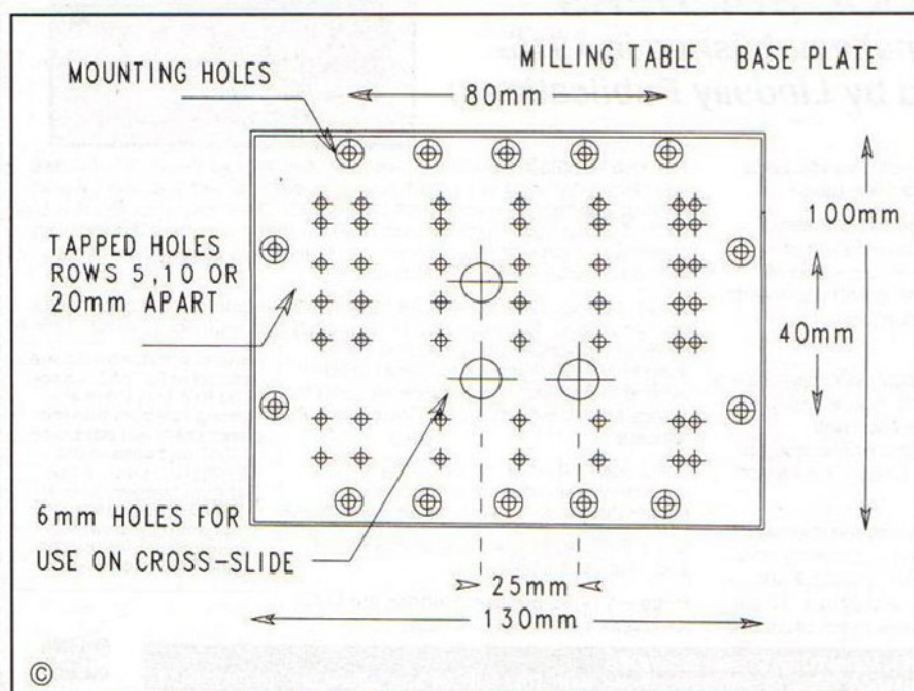
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1: The component parts of the device. The numbers on the parts on the photo are those referred to in the text, which should be consulted for identification.

A UNIVERSAL JIG



This small jig cum machine vice is another interesting item by John Jennings. He has made it with the intention of using it on his Emco Compact Five, but made to his dimensions it will be suitable for any small machine in the home workshop. It is not too dissimilar in principle to methods used in industry on very much larger machines.

The owner of smaller lathes such as the Emco Compact Five and Toyo 360 models have available mill/drill heads to form a small universal machine tool. For the Compact 5 a separate milling table is available which, when combined with the mill/drill head, provides a small milling machine.

When using the mill/drill with a small milling table attached to the lathe cross-slide or the separate base the same problem arises: how do you secure the work to the table to enable machining to take place? The basic problem is that the space surrounding the workpiece is limited and the use of the standard sort of clamps and fingers, including your own, often tricky. Most machine vices are either impossibly bulky or of very limited capacity.

Having recently begun to use my Emco 5 mill/drill/milling base combination more intensively I decided that it was time to address the problem seriously and the result was the jig/machine vice to be described. A word of warning, the project is open ended and it is easy to be tempted to make just one more bit! Make a basic set and then add extra fittings to solve particular difficulties as they arise. Although described for the above combination dimensions can of course be altered as required while retaining rigidity.

As can be seen from the Group Photograph the following elements are included:

- 1) A substantial base unit. This is tapped with a pattern of holes to allow items 2 and 3 to be positioned on a 20mm grid, extra holes allowing closer placement.
- 2) Bars of various cross section to act as rear vice jaws.
- 3) Cross drilled and tapped bars to act as front vice jaws (with or without plain inserts).
- 4) Clamping fingers.
- 5) T-nuts to allow secure fastening to the milling table.

Readers not wishing to embark on the whole project are strongly advised to make a few T-Nuts to match their milling table slots; makeshift, undersize, solutions lead

and estimating the cost produced a figure of £15-£20. However anything that is either flat or reasonably flattenable should do. Mild steel, brass or even light alloy could be used. Again, although surface grinding is the best method of obtaining the flat working surfaces careful milling or filing can give an acceptable finish. The author was intent on producing a working tool and not a tool-room jig; if you want the latter you will need access to appropriate surface grinding facilities for this and many other parts of the project.

Having decided that flatness outweighed any cosmetic defects due to rust I began to trim off the excess inch of plate. It was then I discovered that the material was sterner stuff than mild steel and had a few hard spots, in the manner of cast iron, that stopped the hacksaw blade in its tracks and gently rounded its teeth! Having started however I had to finish. Gauge plate from a known source probably won't be so badly

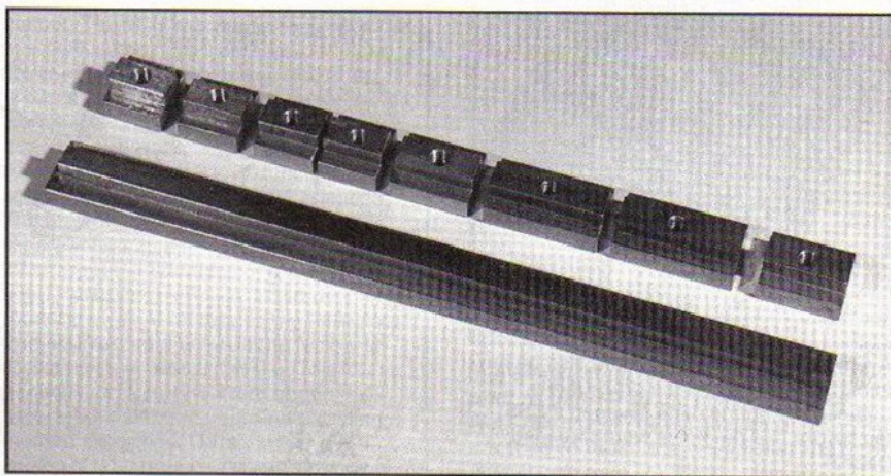
work into several short sessions, preferably divided into logical sections so that you know exactly what stage you have reached when resuming work. I tried several ways of drilling the many holes needed in various parts of this project.

a) Marking out, centre punching and drilling.

b) Coordinate drilling of pilot holes with a centre (Sloccombe) drill, followed by drilling with the correct size tapping or clearance drill.

c) Coordinate drilling with the correct, final size, STUB drill.

Method (c) was by far the most successful in accuracy and ensuring upright holes; it was also quickest! Centre drilled or centre punched pilot holes followed by the use of full length jobber drills was a recipe for holes wandering off-line, fortunately the few holes I drilled by this method (after breaking the only correct size stub drill I had at that stage) were the



2: A length of machined T nut material and a set of T nuts.

G/MACHINE VICE

to over tightening and potential fracture of the slot lips.

The base unit:

This can be almost any size that you desire or can afford, for very large work you can use the milling table itself although flexibility is lost. The size I chose was determined by the material available, by the decision not to overhang the milling table (front to back), to allow the table to be removed and replaced at 90 deg. to the original alignment and finally to enable it to be used as a boring table on the cross slide of the Compact 5 lathe.

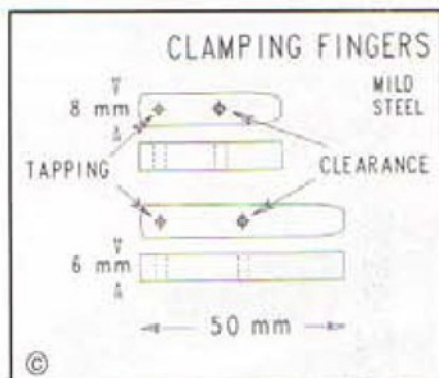
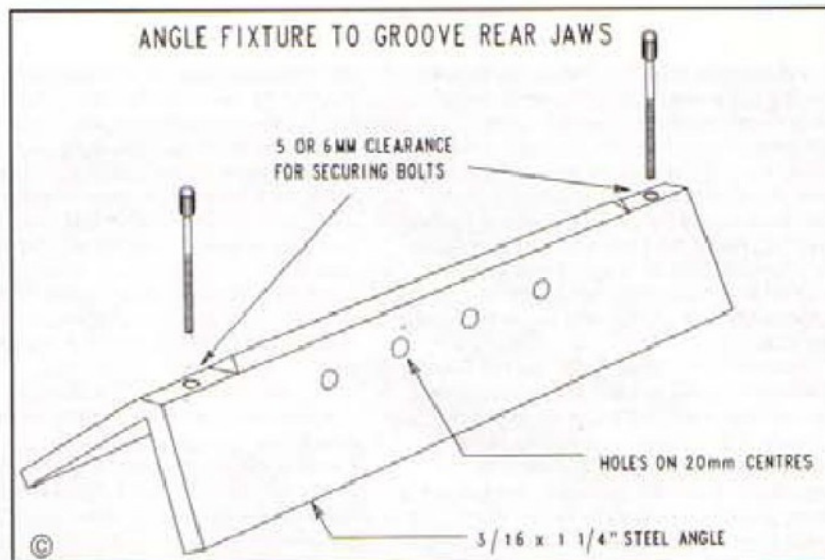
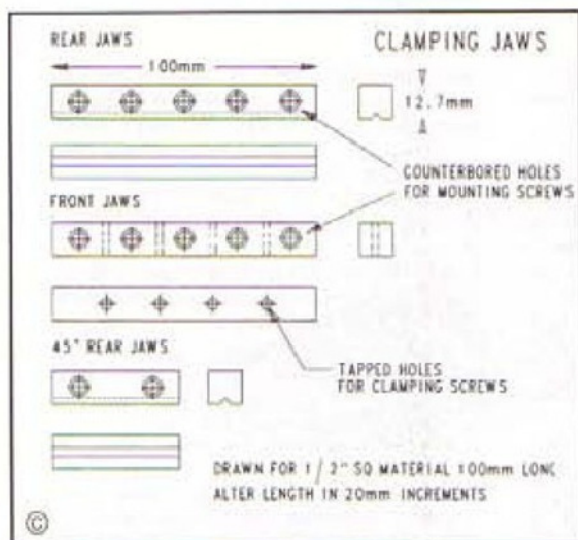
Having decided that a size of 100mm x 130mm and 10-12mm thickness was appropriate I searched the material store/scrapbox for something suitable and found a piece of rather rusty 1/2in. thick steel plate a little over size in one dimension but which appeared to have been ground flat. As related below this proved to be an odd end of gauge plate or similar and when finished was ideal. Constructors will however probably have some difficulty in finding a supplier of such a chunk, none of my postal suppliers had anything so large,

behaved but even so I would recommend you buy it cut to size if possible. If you can acquire a small off-cut of the same material you may find it useful (as I did with my hard won excess) to use for dummy runs of some of the later operations. Having cut the material to size I then milled all four edges, clamping the material on the milling table with packing underneath. I am not sure how much wear was sustained by the endmill, it may be more economic to clean up the edges with a file. Clean purchased material should need little effort here.

The next step in construction is to drill a pattern of tapping holes to enable the other parts of the jig to be bolted on to the base at variable spacings and clearance holes to enable the jig base to be bolted to the milling table or cross-slide, all the clearance holes are counter bored to leave the face of the plate clear when in use. The basic pattern of holes is a 20mm grid which is half the separation of the T-slots on the milling table.

There are a lot of holes! When you have completed the full pattern you will know a thing or two about drilling and tapping holes. I would recommend splitting the

cross-drilled clamping screws on one set of vice jaws where the alignment was not so critical. I used UNC 8x32 cap head bolts for fastening items to the base plate (only because I had several hundred bought at about 1p each as a surplus line). A suitable alternative would be 4.00mm x 0.7mm or 3BA. If you use rectangular bars instead of 1/2in. square for the small version of item (2) you could use 5mm x 0.8mm or 2BA but the two rows of holes 5mm apart will need more separation. Having decided what bolts you are using you need to decide the size for the tapping drill, use a rather larger size than normally recommended, 60-70% engagement will suffice. Remember that you are tapping some fifty holes in the plate and you cannot really afford to break any taps, with the hard tough material I used, not only did I use a generous tapping drill I also opened out the drilled holes to clearing size from the bottom side leaving about 6mm to actually be tapped. This is where an offcut for trial runs is so useful. Before starting you will need to purchase stub drills of the required sizes (ref *1.) and I would suggest you purchase three or four of each size required to allow for breakage and the need for immediate resharpening.



A similar supply of taps should also be put in hand, as even with the precautions outlined my gauge plate savaged a HSS tap before half the holes were threaded (ref.*2).

Begin by drilling the outer clearance holes, I suggest that you treat the eight along the long sides and the four along the short sides as separate groups. Mark out the lines on which the holes will fall and centre punch at least one centre for each group. Clamp the plate to the milling table, aligning it with the axes of the table, with a spacer underneath (plastic faced chipboard is ideal) so that you can drill right through. Before drilling check that you can reach all the holes that you want to drill and locate on the pipped hole. To avoid backlash approach the final location so that you will move in the same direction when you go on to the next hole. Before drilling adjust the slip rings on the milling table dials to zero (I only found out recently that they could be adjusted on the Emco 5 table!).

After drilling the first hole, using ample cutting oil, move on to the second hole until the set is complete. Locate on the second pipped centre and repeat the above process. The next task is the drilling of the tapping holes, again decide where one of the corner holes of the network of holes should be and centre punch. Clamp to the table as above and similarly drill the holes. It may be useful to draw on a piece of stiff card the required separation of the holes in each direction so that the hole location can be checked if you think that you have miscounted the number of whole handwheel rotations. During this sequence you may need to change the drill as it may blunt on the tougher options for the base

(ref.*1) Mill Hill Supplies list these.

(ref.*2) Tracy Tools is a good source particularly of UNC/UNF.

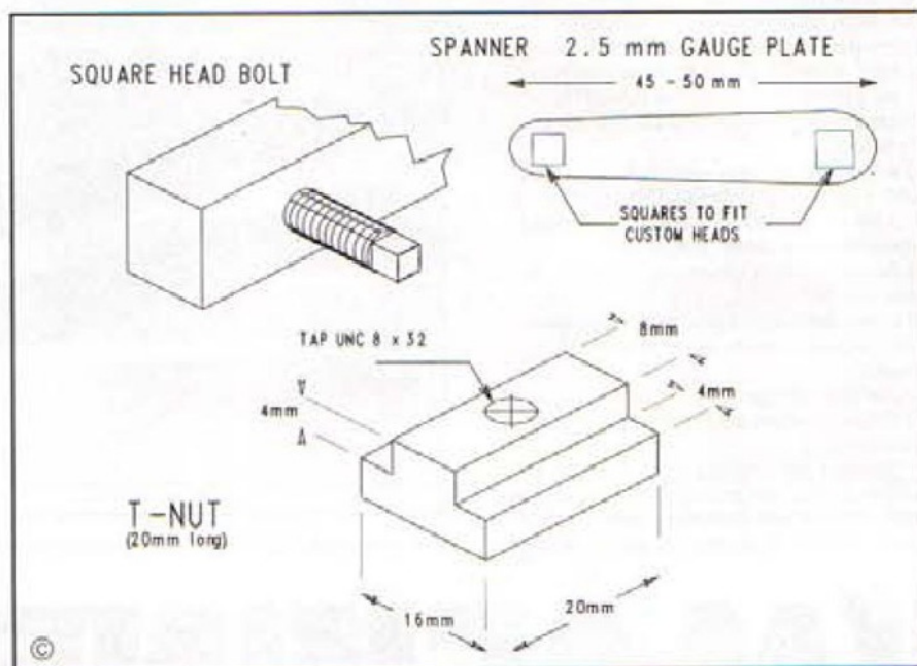


plate material. The third step of drilling is to drill the optional largest holes to enable the base plate to be mounted on the lathe cross slide, by now this should cause you no difficulty!

Counterbore the clearance holes to accommodate the cap head screws that you are using. In the absence of a proper counterbore with a pilot, an end mill can be used, prior countersinking of the hole to just over the required size will help location and prevent any tendency to skid around the correct location (these light mill/drills are not totally rigid). I only had trouble with the three large holes and I suspect that it was caused by the endmill used being less than sharp.

Finally, if thought necessary, open out the tapping holes to clearance size for up to half depth from the bottom of the plate. Use a depth stop to prevent inadvertent all-through drilling. "Freehand" drilling should suffice for these holes.

It remains to tap the 49 or so holes. This needs to be done with both care and attention to details. If you are not bolting down the plate during the tapping process do grip securely, it is heavy and will destroy a tap and possibly damage you if dropped. Do use sharp taps, replacing when they appear to be cutting less effectively. Do use taper then second cut

taps (using plug taps is probably not necessary). Do use ample cutting compound. Do reverse the tap to break the swarf and remove the tap to clean off the accumulated swarf (this is one drawback of cutting compounds - that they stick swarf particles together). Do start the tap squarely. If the tap appears to jam rock it gently until it clears.

If a tap breaks examine the wreckage carefully. Taps in this size are too small to use a commercial tap extractor but if a stump is accessible you may be able to grip it with a pin chuck core (i.e. with the closing cone removed). Use plenty of thin oil and rock the remains. If you can't move it you may be able to break the tap up by chipping at it with a small sharp and hard chisel-ended punch. Remove any bits with fine tweezers as soon as they are formed. Finally brutality with a flat punch and large hammer may knock the tap out. There will be a balance between defacing the workpiece and removing the tap and if all else fails you may just have to do without that particular hole. If you are using easier working materials than gauge plate you may think it is worthwhile to make a small core drill and drill round the remains and then plug, re-drill and tap your desired hole.

Even with the oversize tapping hole that

I used there was some tendency to raise a slight bulge round the tapped holes. This was removed with a fine file and the plate finished by graining with a small block of "Water of Ayr Stone", this is a clock-makers material which is a soft slate like substance which contains small very sharp particles of abrasive (see M.E.W. issue 14 page 10 Ed.). After cleaning up round the tapped holes it was used to grain the surface along both diagonals giving a subtle chequer board effect.

Wash all the cutting compound and swarf off the workpiece and then re-oil with WD40 or similar before it has time to rust, particularly in the tapped holes.

Constructors have now completed the most difficult part of the project, all the remaining bits and pieces are simple enough to re-make at no great cost in time or materials if things go wrong.

The rear vice jaws

As will be seen from the drawings, which are drawn for $\frac{1}{2}$ in. square section, these consist of short lengths of mild steel bar (the material is a compromise between wear and effort) drilled to take the bolts that fasten them to the base plate. I also made bars of $\frac{3}{4}$ in. and $\frac{1}{2}$ in. square cross section, almost any size up to 1in. square might be used to meet particular needs. If you are able to choose the raw material select bars with sharp edges and flat sides some smaller MS section is rather poor in this respect. Except for the smallest bars the holes are also counter-bored to leave the top surface clear in use. The smallest bars I made were from $\frac{1}{2}$ in. square material and do not have sufficient thickness or width to counter-bore, if constructors need to hold a lot of thin work without obstruction the solution would be to use rectangular bars $\frac{1}{2}$ in. or $\frac{3}{4}$ in. wide and countersink the holes. To make the bars I mounted a small machine vice on the cross slide of my Unimat 3 and cut the required lengths off with a slitting saw blade (not too thin - I used one 0.020in. thick x $2\frac{1}{2}$ in.) use a steady, slow, rate of feed and the blade will sing through the metal giving square ends that apart from breaking the sharp edges a little I left untouched. The $\frac{1}{2}$ in. bars were too large to cut in one go by this method but rotating the material and carefully realigning proved successful. The longer bars will be found to foul the headstock and they will need roughly hacksawing to oversize lengths before each end is trimmed square. Mark out the centre line of at least one bar of each cross section and centre punch the location on one of the end holes (assuming there are more than two). Transfer to the mill/drill and locate the centre pip and drill through, move the workpiece the desired 20mm and drill the next hole as you did for the base plate. I held the bars in a machine vice for this step and a spacer was required to raise the workpiece nearer the top of the jaws. When drilling a number of through holes, as is the case here, a spacer that is not slowly destroyed is useful and a short length of channel used open side upwards is ideal. It should be very slightly thinner than the workpiece, a slight skim with a file may be required if they are to nearly the same size. When all the bars are drilled those that are thick enough should be counter-bored to suit the chosen cap screws. I made no attempt to make the bars exactly to length but if constructors

wish to do so I suggest that they modify the order of working as follows. Cut all the bars roughly to length, make them about $\frac{1}{2}$ in. too long, and clean off any ragged edges. Drill the holes as described above. Make a mounting jig with holes 20mm apart tapped to suit your chosen thread. Hold the jig in the machine vice, mount a bar on this jig and position for the desired trimming cut and lock the carriage feed. Trim, remount the bar and trim the other end. Repeat for all the other bars. This process should give a set of bars whose ends should align across the base unit when in use.

Some or all of the bars can be elaborated with extra holes or grooves, as standard. I decided to mill a V-groove along one face of the $\frac{1}{2}$ in. and $\frac{3}{4}$ in. square bars to facilitate holding round work. A simple fitment was made from $1\frac{1}{4}$ x $\frac{3}{4}$ in. square edged angle to mount the bars for milling. The mounting holes on the jig should allow a degree of movement to accurately align the bar. The best procedure seemed to be to scribe several lines parallel to the axis of the workpiece, set up by eye and after taking a light cut adjust the position of the workpiece to correct errors. Both the jig itself and the workpiece may need adjusting. It sounds more difficult than it is and no problem should be experienced. The drawings show one bar with a hole separation of 28.28mm rather than the 20mm module adopted for the other bars, this dimension is of course that required to mount the bar at 45 deg. to the baseplate grid and two bars provide the facility to clamp discs securely. It will be found perfectly straightforward to obtain the separation using the coordinate drilling method described. Other, rather odd, angles can be obtained in the same way by calculating the hole separation required.

All the jaw bars were finished by draw filing on a large fine file, pressing the workpiece hard down on to the file avoided rounding the workpiece.

The front jaws

These are basically similar to the rear jaws described above and the initial stages of production can be combined. The major difference is that these bars will be left plain but cross drilled and tapped to take bolts to clamp workpieces between the jaws. For the $\frac{1}{2}$ in. and $\frac{3}{4}$ in. square bars I used a UNF 10 x 32 thread (for the same reasons as above) close alternatives would be 5mm x 0.8 or 2BA. For the 5/16in. high jaws the smaller thread previously used must be used and to prevent the bars bending under stress they must be $\frac{1}{2}$ in. x $\frac{1}{2}$ in. rather than square section. The ideal bolt to use is a hexagon socket headless (set) screw which will cause the minimum obstruction and will physically limit over-tightening. If you cannot obtain or afford these in the longer lengths required an alternative is to make your own square headed sets by grinding suitable HT studs or bolts and making a square key to match.

For many purposes direct clamping by the cross bolts will be adequate. But while sawing up my stock of mild steel for this project I did make a set of loose jaws for the standard $\frac{1}{2}$ in. square jaws, these are rather thick at $\frac{3}{4}$ in. x $\frac{1}{2}$ in. and are cut to the length of the fixed jaws. There is obviously scope for soft jaws and I have a supply of $\frac{1}{2}$ in. thick Tufnol off cuts to make front and rear liners when time permits.

Clamping fingers

There will be occasions when the standard bars are inadequate to hold irregularly shaped objects. In these cases hold-down fingers may be useful either alone or in conjunction with the standard bars. Construction is straightforward and open to whatever variations you require and I give dimensions just for a basic set of small clamps. Push on hard nylon "boots" for the bolt that bears down on the base plate will reduce marking of the plate and for some purposes extra holes tapped into the jaw bars may be useful.

T-nuts

To bolt objects onto T-slotted milling tables in a safe manner T-nuts or preferably T-bars of the correct size to fill the T-slots are required.



3: A block set-up on the Jig/Machine Vice prior to transfer to the milling machine. Note the use of square headed bolts which are used to retain the workpiece. The front jaws in use here are the $\frac{3}{4}$ x $\frac{1}{2}$ in size.

The drawings give dimensions for the Emco 5 Milling table. They should be made from lengths of T-bar material rather than individually. Clamp a 220mm, 9in. length of $\frac{3}{4}$ x $\frac{1}{2}$ in. mild steel on to the milling table (using whatever clamps you have). If possible clamp a second strip of metal alongside the work piece to help resist the sideways forces caused by milling. Your clamping should allow access to the whole of one side. With a sharp end mill, about $\frac{1}{8}$ in. dia. will do, mill a step 3.5mm deep and 4mm wide in several passes. Re-clamp the work to expose the other edge and repeat the milling process, checking that you are milling parallel to the first cut. The centre spine should be just under 8mm wide. Clean off any ragged edges and try the fit in the T-slots. While you are set up I would recommend that you make another one or two lengths - I used a whole two foot length of material bought in for the purpose. The remaining stages are again straightforward. Cut the material into short lengths between 16mm, which gives a square T-nut, and 50mm in length and in pairs. Organise how you are going to cut the bar into these lengths before you start, you may need to plan the cutting up of two bars to obtain the selection of lengths you want without wastage. Finally mark out, drill and tap for the screw thread you have adopted. I also made some bars with 5mm and 6mm holes to accept existing accessories. Longer bars with two holes for special purposes may be made up - but they are rather inflexible in use.



A: Shows a home made polishing machine.

B: Shows the motor mounted behind the machine.

C: Shows the spindle with tapered threads and pulleys.

D: Shows a powerful industrial polishing machine, 3hp, 3000 rpm, single speed.

METAL POLISHING

This article by Alan Jeeves on metal polishing, nicely complements the article on metal spinning that was published in the last issue, also provided by Alan.

Most metals which are used by amateurs in their home workshops are capable of taking a very high polish indeed. Copper, brass, aluminium, steel, stainless steel, can all be transformed from the standard lustre produced by machining to a magnificent mirror finish which will be admired by all who see the work. The problem is not how to produce a high quality finish, but how to do it in a reasonably short time. Polishing is a very tedious way of passing one's time and the key to it all is having the right equipment to hand. These days the equipment is available to anyone with a small amount of space and modest amount of cash to fund it. A range of equipment is usually built up over a period of time. As the selection of mops and polishes expands, so does the skill to use them, until extremely satisfying results are obtained without the investment of hours and hours of work which hand polishing demands.

Attachments can be had from many model engineering suppliers to fit lathe chucks or portable drills. These usually

consist of a threaded cone with a shank which can be gripped in a chuck. The thread on the cone allows a cloth or felt polishing mop to screw itself on, forming a thread in the bore of the mop, and it can be screwed on and off the arbor many times. Some attachments are simply parallel arbors, gripped in a chuck, and two large washers sandwich the mop as a nut is tightened at the other end. Some of these have a domed head at one end and because of this are called 'mushroom arbors'. The preferred means of mounting polishing mops, however, is directly onto the spindle of a machine which has been designed for that purpose.

Equipment

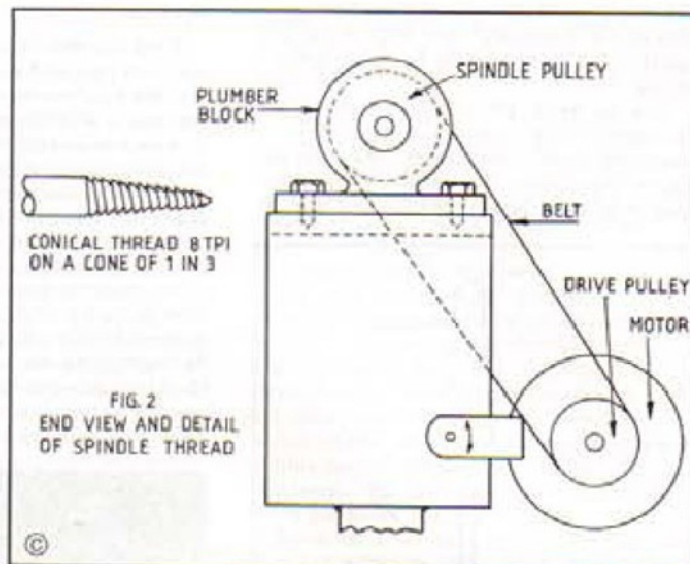
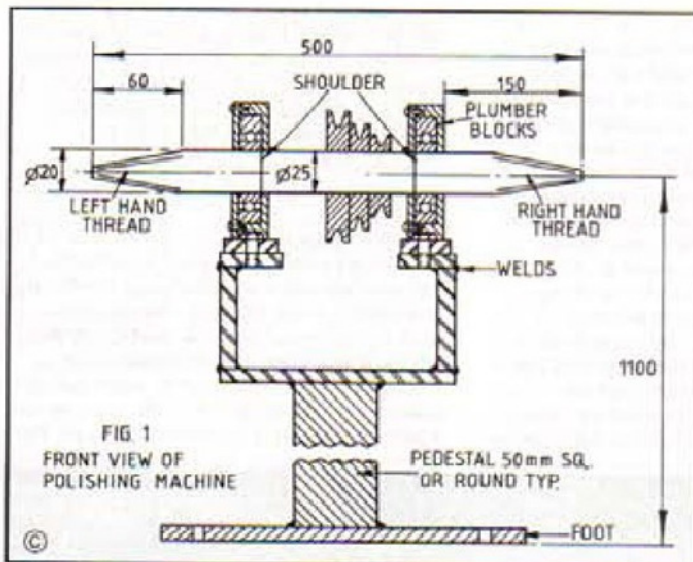
Before any form of polishing machine is used by anyone, anywhere, the operator **must** be wearing effective eye protection and a good quality mask to prevent him from inhaling the dust which is produced when polishing. These items are essential. A good pair of gloves should be considered as should some form of protective clothing such as an apron and a hat. The polishers' two worst enemies are the dirt produced and the heat generated as the work progresses.

The simplest form of purpose built polishing machine I have encountered was an electric motor with a long spindle in the form of a sleeve which slid over the motor spindle and was secured by a grub screw. The mop could then be screwed onto the tapered thread with which the sleeve was

equipped. Provided that the sleeve runs true and is firmly fastened, and the motor is of sufficient power and securely fastened down, good results should be obtained from this arrangement. The mop should have plenty of free space all around it. Nothing for the hands or the work to get trapped against when the wheel is running. There is no work rest on a polishing machine, the work is just held against the wheel and pressure is applied.

The next step up is the imported bench mounted machine which resembles a double ended grinder except that the right hand spindle is extended to form a polishing spindle whilst the left hand spindle is close to the body and is fitted with a wire brush. These machines are single phase, ½ horse power (375 watts), and run at 3000 r.p.m. no load speed. They come complete with mop and wire brush and represent good value for money for the amateur. The idea is to mount the unit on the bench with the long spindle overhanging the end of the bench. An alternative and, I believe, superior method of mounting is to make a simple pedestal onto which it can be bolted, thus forming a machine which is comfortable to work with. It is important to remember that even though these machines (as well as standard bench grinders) are supplied with clear eye shields, personal eye protection should still be worn.

If you require a larger or more powerful polishing machine various pedestal models are available but are really intended for

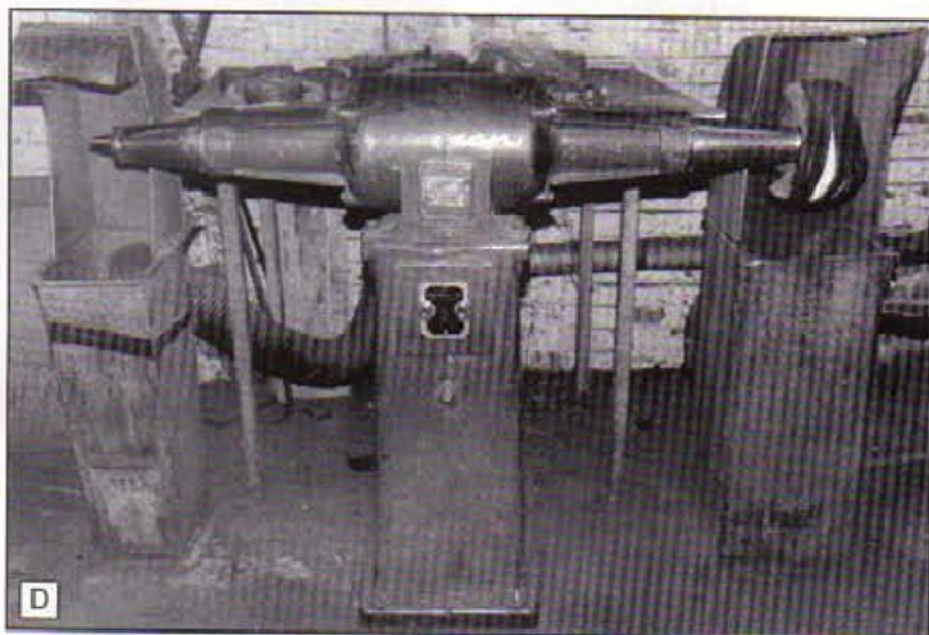


industrial use. However, an option is to build one to suit your own requirements. Spindles of different types are available separately as well as suitable bearings to mount them on. Driven by a motor of at least $\frac{1}{2}$ horse power (375 watts) a really good machine can easily be built. For the more ambitious the spindle can be produced on the lathe, especially by those who can cut a tapered thread. A few details are, therefore, provided (figs. 1 & 2) as a guideline to anyone wishing to construct a machine similar to those shown in **photograph A**. This machine should cope with all the work likely to be encountered in the average home workshop. Another advantage of building your own is that it can be multi-speed, the one shown having 3 speeds. A greater range of mop diameters can then be fitted using the different speed ranges. The machines built by the various manufacturers are usually of a type which utilise the motor spindle and are therefore restricted to one speed, usually 3000 r.p.m.

It is a good idea to include guards of some kind to restrict the flying particles of metal and polish. The debris from polishing really does get everywhere.

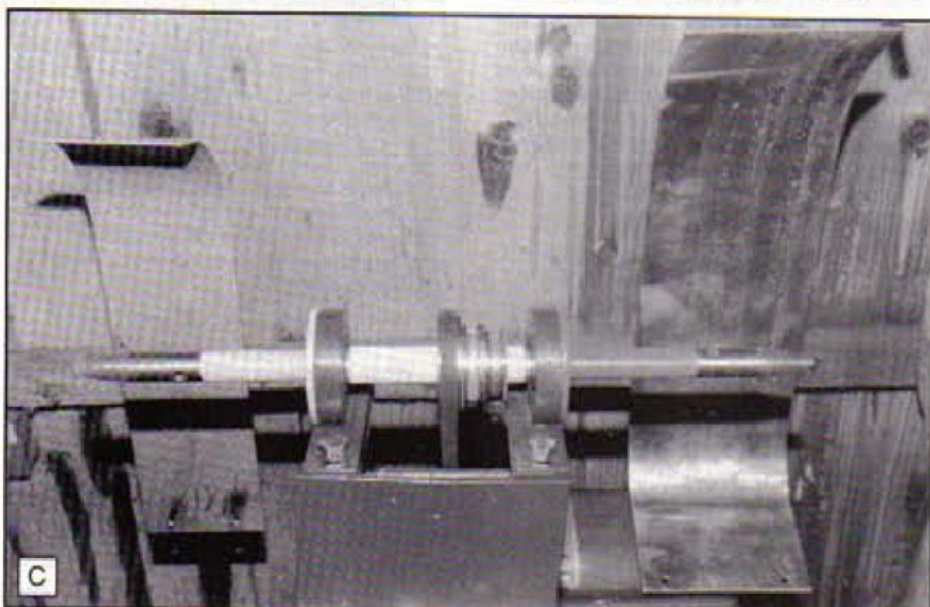
Mops

The choice of mops available from a good supplier is quite large and mops should be acquired according to the type of



work to be undertaken. General duty mops are mainly made of cotton or wool for baking on compound, and felt for charging with polishes which come in block form. For very fine quality work mops are available which are made from 'swansdown' which is a type of cotton fabric and not actual swans feathers.

Most work will be carried out with circular mops which range from 12mm to 50mm wide and from 50mm to 250mm in diameter and which come in different textures. For roughing out a job, the mops are quite hard 'stitched mops' which consist of a number of cloth discs which are stitched together to form a wheel. The discs are so arranged that the warp on one disc is aligned with the weft on the next, thus producing a kind of lamination. Down the centre is a small hole which is reinforced at each side by a leather or fibre flange which helps to prevent the cloth from tearing when mounted on the spindle. These will be the most common in the home workshop. Some of these mops are described as 'calico' mops. Calico is simply a cotton woven material which was first made in Calicut, India. This town was formerly known as Caleco and the material is named after it. Another type of stitched mop is known as an 'impregnated stitched mop'. It is reinforced by strands of sisal sandwiched between the cotton discs, sisal being a South American agave plant having leaves which yield a stiff hemp-like fibre. The strands are arranged like wheel spokes and give the mop a firm structure to withstand more pressure when polishing. For finishing work the mops are much softer, being made from cloth discs which



are not stitched together and are free to flap about. These are 'open fold' mops and pressure cannot be applied to them when in use.

The felt 'bobs' are very dense and when charged with abrasive are capable of removing metal quite rapidly. They can be had in wheel form like stitched mops, and also shaped cones and 'felt fingers' (fig. 3)



FIG. 3
A FELT FINGER MOUNTED
ON AN ARBOR.

are available for getting inside small hollow ware. They are very useful indeed on the enormous variety of small components associated with model engineering. Perhaps of less importance to the model engineer are 'cabbage mops'. These take the form of a tapered cloth cylinder which is screwed onto the machine spindle and charged with abrasive on the end face. They can be used to polish such items as inside pan bottoms, where a conventional mop is of little use.

When a mop is acquired it must be screwed onto the spindle squarely so as to cause as little vibration as possible. This is easy after a little practice. When re-mounting a used mop, all that is required is to offer it to the spindle with the machine running and it will screw itself on. At this stage it is worth mentioning that on the double ended machines, the right hand spindle nose has a left hand thread to ensure that the mops cannot work their way off.

HIDDEN DETAIL

Fettler asks...

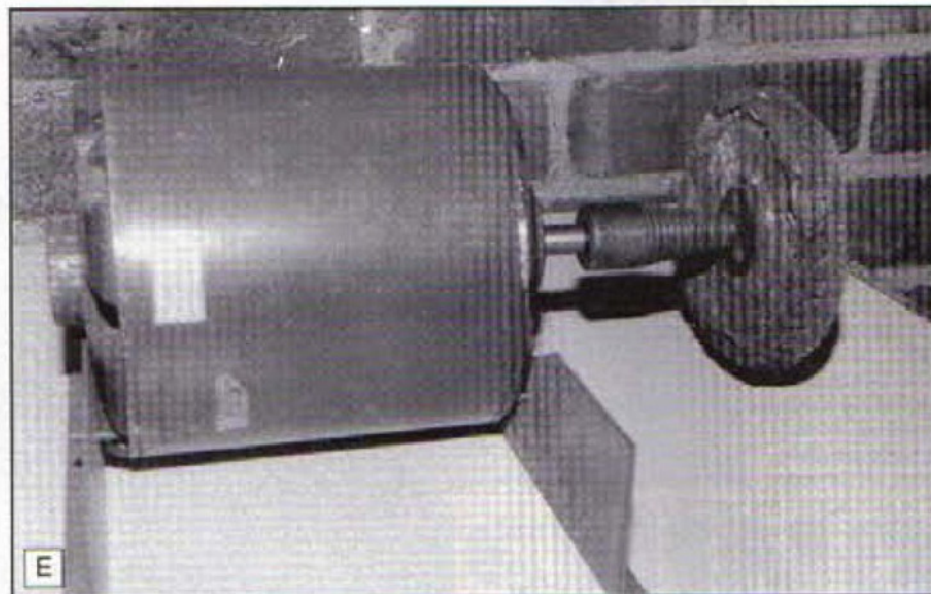
Why is it that after you've just made the smallest and most intricate part for your project when, smugly, having set it on the bench to admire it, it rolls toward you as if with a life of its own, drops off the edge, lands on your foot, and promptly seeks cover in the grot in one of the most inaccessible unswept recesses of your workshop?

Then, why is it that if you don't find it, and take the advice (?) often given, and drop a similar item in like manner to watch where it goes – on the mistaken premise that it will lead you to the first – you lose sight of that as well?

I even lost a small BA spanner for 6 weeks on one occasion, and now I've lost my 'pet' 4in. rule, and my workshop floor is cleaner now than ever it was. I reckon they both grew legs and ran off when I wasn't looking!

Speeds

If we express the cutting speed of the abrasive mop in ft/min. of the periphery, and the machine on which it is being used has only a single speed, then it will be clear that each diameter of mop will have a different cutting speed. For example, most experienced home workshop engineers seem to put the preferred cutting speed for polishing at around 4000 ft/min. If the spindle is revolving at a speed of 3000 r.p.m., then the diameter of the mop will have to be 5in. (125 mm) to achieve the preferred cutting speed. This is arrived at by multiplying the mop diameter (5in.) by π (3.142) to give the circumference (or periphery) which is 15.71 inches or 1.3ft. This, multiplied by 3000 (rpm) = 4000ft/min.



As the diameter of the mops increase, so does the cutting speed.

One advantage of having a polishing machine in the workshop is that an emery belt can be fitted to a suitable mop; rather like a tyre on a wheel and, when mounted on the spindle, forms a finishing wheel which will remove metal faster than polishing. However, the ideal cutting speed for an emery belt is somewhat lower than a polishing mop at about 3000 ft/min. Using an 18inch long belt the diameter of the wheel it is fitted to is 5.73 inches or 0.48ft. It is a good size to use but the cutting speed at 3000 rpm is 4500ft/min., far too fast. To obtain a cutting speed of 3000ft/min., the wheel diameter must be 3.28 in., making the length of the belt 12 inches. Not a good size. The answer, therefore is to have more than one speed, hence my earlier comments on a home built, multi-speed machine.

Polishes

Polishing abrasives come in three main forms. Rubbery compounds which are baked on, blocks which resemble ingots and are re-applied whenever necessary, and liquid polishes which are applied to the mop and absorbed into the surface. There are many different kinds of each and it is quite confusing trying to decide which to buy. Most of them are intended for use in industry where production speed is a major concern. Perhaps this is of somewhat less importance to the home user. Generally speaking the coarsest polish the model

engineer will see is 80 grit and the finest will be 220 grit. Having said that, some jewellers compounds are very fine indeed. 'Jewellers rouge' is a very useful product to have and the diamond compounds give exceptional results, going down to a fineness of 800 grit, but for general workshop use these will seldom be needed.

The storage of polishes is also important as they are affected by air. The rubbery compounds come in a plastic or cardboard tube which, once opened, should be re-sealed after use. They will rapidly harden if left exposed to air for a few days. It is probably better to re-seal the tube and also keep it in an air tight container until needed again. It must be remembered though, that

E: Shows a motor with a sleeve fitted over the spindle to mount the mop onto.
F: Shows a mop mounted onto a taper threaded arbor.



one grade of polish should not be allowed to come into contact with another or a fine compound may be contaminated with a coarse compound, causing havoc when applied to the job.

Polishing

When polishing is taking place, metal is being removed from the object being worked on, making this a cutting operation. The cutting is being carried out by the abrasive which has been applied to the mop, turning it into a very fine grinding wheel. All that happens is that any machining marks or scars are removed,

leaving a new series of scratches which are uniform in texture. These scratches are then removed by using a finer abrasive, leaving a series of finer scratches which are in turn removed by an even finer abrasive and so on until the required finish is produced. It will be clear that it is an advantage to have a separate mop for each grade of abrasive, although it is possible to charge one mop with different abrasives provided that all the previous coarser abrasive is completely removed with a wire brush before the next grade is applied. It is worth mentioning that a special wire brush is available which is provided with two handles to ensure a good grip with both hands when cleaning up a mop. A standard wire brush can, of course, be modified at home to give the same result. The mop chosen to start with will depend on the surface finish apparent on the work at the commencing stage. A job may already have been polished in the past and all that is required is a reinstatement of the original finish. On the other hand a job may have machining marks equal to a surface roughness of 12.5 μm (μm =micrometres or 0.001mm), or suffer from hammer blows or other blemishes, in which case a finishing wheel will be chosen to 'break' the surface. Usually emery belts are glued onto a suitably sized mop and, when exhausted, removed and a replacement fitted. I have found that in the home workshop a suitable system for making up finishing wheels is to glue a belt onto a mop and when it is set the sharpness is taken off by using it on a piece of scrap metal. Further emery belts can now be fitted over the original without gluing. I use three strips of thin sheet metal to guide the new belt on (fig. 4).

Belts are available in many different

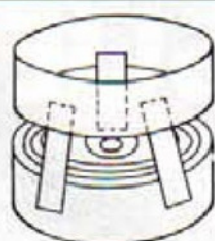


FIG. 4
FITTING AN EMERY BELT
ONTO A FINISHING WHEEL.

lengths, and four grit sizes are generally available too, being: 40, 60, 80, 120, in descending order of roughness. A 40 grit belt will really remove metal at 3000ft/min., (1 mile in 1 min-45.5 secs) but there is little point in finishing down to 120 grit and then starting to polish with 80 grit polish. Eventually experience will decide when to start with the polishing mop.

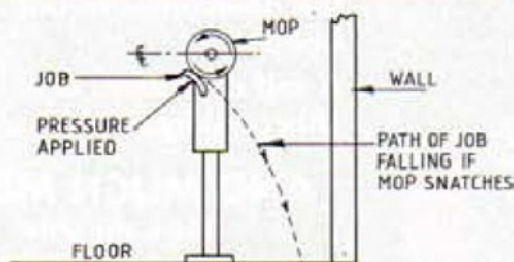


FIG. 5 SHOWING APPLICATION OF WORK TO MOP

Probably the most successful polishing abrasives are the rubbery compound type. To charge the mop the spindle is set running and then switched off. The tube of polish is applied to the mop as it is slowing down, allowing the surface to be charged. This process is repeated until the surface of the mop is completely covered with compound. The mop is then removed from the spindle and placed in some form of oven to bake the compound on leaving a hard shell-like surface on the mop. Not a great deal of heat is required to do the baking, 80 deg. C. should be sufficient. Alternatively if the compound is left to harden in air, a shell will be produced, but it will take a lot longer. Having a hard surface on the mop assists the rapid removal of metal from the work. The procedure is the same through all grades of abrasive until the required finish is obtained.

The polishes in block form do not have to be baked on. They are applied in the same way but the mop is ready to use straight away. Because of the softness of the cutting surface, these polishes cause the mop to 'glaze up'. The polish appears to be shiny or glazed. This is because after a while the mop also becomes charged with the metal being removed. It has to go somewhere. At this point the progress being made can start to go backwards because the metal particles in the mop can scratch the job and make it rougher. It is important to clean the mop regularly with the wire brush and apply more polish if required. Glazing up should be avoided. When a suitable finish has been accomplished with one grade of polish the job has to be cleaned of all traces of that polish before the next grade is used to remove any surplus that remains on the job.

Polishes in fluid form are for fine polishing only. They are really designed for superficial polishing of ornaments in the home, being applied to the object by hand with a cloth. They can be applied to a mop and used on the polishing machine. They are particularly useful for work on plastics, but will polish metal too if a super fine finish is required.

Having chosen the type of polish to use, all that is required is to hold the workpiece firmly against the revolving mop and apply a small amount of pressure. The job is always held against the mop below centre height. The reason for this is that if the mop snatches the job out of the operator's hand it is thrown away from him and to the floor (fig. 5). It is important to note, therefore, the direction in which the spindle should rotate (fig. 6).

It is useful to have a light above the machine, as good light is essential to be able to see what is happening to the work. What may appear to be a flawless job in bad light shows up to have many flaws

when inspected under a good light. A bucket of water may also be useful as heat is generated quite rapidly and the small job soon becomes too hot to hold.

The polishing of outside surfaces is accomplished very easily when a little experience has been gained but inner surfaces, such as pipe bores, can be polished easily too. By using felt bobs, cones or 'felt fingers' most surfaces on a component can be dealt with. In certain cases special bobs may be made or existing ones modified to suit an odd job and the experienced polisher amasses many different polishing heads. Some manufacturers supply excellent 'introductory assortment kits' containing small wheels, points, and cones. These are highly recommended for the model engineer. There are catalogues available from suppliers of polishers requisites, the offering by J. Simble & Sons (76 Queens Road, Watford tel. 0923 226052) being a particularly useful source.

Buffing

Having produced a finish which satisfies the need for it, the job can be 'buffed up' to give it that final sparkle. Buffing is really the cleaning of the job when the polishing has been completed. It removes traces of polish and gets rid of 'graining' where the polishing marks run in one direction or another. Strictly speaking the difference between buffing and polishing is, whereas polishing makes use of a mop onto which has been applied a hard shell of abrasive (usually baked on), buffing is carried out with mops charged with the softer block compounds and soaps. However it is generally understood that buffing is the fine finishing of an article after polishing, or the re-instatement of a high quality finish that has become soiled or tarnished.

Notes on the selection of pulleys

For those who wish to build a polishing machine for themselves, most of the material can be obtained from scrap. The pedestal, for example, can be made out of any suitable material, square, round or rectangular tube for instance, or angle iron if that is available. On my machine, just the motor, belt, and two bearings were purchased, the remainder being fabricated from scrap. I even made the 'plummer blocks' to press the bearings into. Of course a welder is handy for joining the different sections together, but not essential. The pulleys, however, will have to be selected with care. If the machine is to be multi-speed, the spindle speeds will have to be achieved keeping the belt length close to the same across the range of pulleys. Some adjustment for tensioning the belt should be incorporated into the

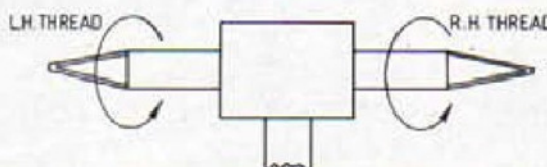


FIG. 6 VIEW OF POLISHING SPINDLE FROM FRONT
SHOWING DIRECTION OF ROTATION.

G: Shows a small jewellers or gunsmiths polishing machine for small parts only.

design but there is a limit to how much it will move. The pulleys should, then, be of diameters which will maintain the approximate belt length. I offer a quick calculation for determining the belt length over pulleys of given diameters across given shaft centres.

$$2c + 1.57 \times \frac{D\pi}{2} + \frac{d\pi}{2}$$

Where c = Distance between pulley centers.
D = Pitch diameter of large pulley.
d = Pitch diameter of small pulley.

I also offer a combination of pulleys suitable for a polishing machine having either a 1420 r.p.m. motor or a 2840 r.p.m. motor.

These 3 gang pulleys will probably have to be made but they may be obtainable as individual pulleys and then ganged together.

Pulleys for 1420 r.p.m. motor

Driver	Driven	Speed
120	85	2005 r.p.m.
140	65	3058 r.p.m.
155	55	4000 r.p.m.

Pulleys for 2840 r.p.m. motor

Driver	Driven	Speed
65	90	2051 r.p.m.
80	75	3029 r.p.m.
90	65	3932 r.p.m.



Useful formula

To find the required r.p.m. for a given surface speed in ft/min.

$$\frac{\text{ft/min.} \times 12}{\text{Mop circumference in inches}} = \text{r.p.m.}$$

To find the ideal diameter of a mop for a given surface speed and r.p.m.

$$\frac{\text{Surface speed in ft/min.} \times 3.82}{\text{R.P.M.}} = \text{mop diameter.}$$

$$\begin{aligned} 1 \text{ ft/min.} &= 0.005 \text{ metres/second} \\ 1 \text{ m/sec.} &= 196.85 \text{ ft/min.} \end{aligned}$$

As a much younger man I used to visit a firm of metal finishers in Tottenham. The operatives at that establishment chose to wear hats made from newspaper, somewhat after the style of the toy boats that most kids had folded up for them by an indulgent parent, uncle or grandfather in that era. The lads claimed that no headgear would remain unsullied by the throw-offs from the polishing mops hence their choice of disposable headgear. They claimed that The Times or The Guardian made the best headgear, the paper being stronger than the other large format dailies. At this length of time I cannot remember how to fold the sheet of paper to make a hat, but venture to suggest that someone out there could tell us. Ed.

QUICK TIP

When sharpening spring joint dividers they can be dismantled by opening fully with the adjusting nut and then pulling closed by hand. Put a wedge into the spring (e.g. use a drill drift) and release the legs. Each leg can now be removed from the pivot roller and separated from the adjusting screw. Each point can be sharpened individually and the instrument re-assembled in reverse order.

Alan Jeeves

IN OUR NEXT ISSUE!

Coming up in the June/July issue No.17 will be:

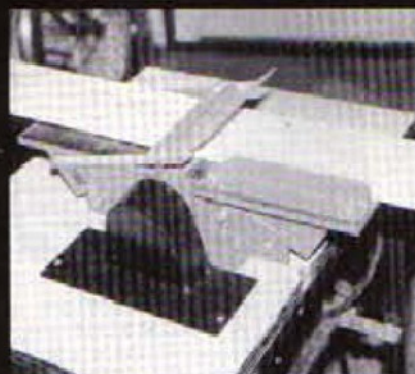
A fabricated wood plane, a major constructional project.



A heavy duty dial test indicator base, some useful milling exercises in particular machining tee slots.

An economy tee slot cutter, avoid having to purchase an expensive cutter to complete the DTI base.

One reader's experiences in making the Dore Westbury mill/drill.



Workshop basics for beginners, some advice for the newcomer to our hobby.

A self contained drill sharpening machine.

AND MUCH MORE

Issue on sale

15th April 1993

Contents may be changed

TRADE COUNTER

A first look at products which may be new to you, plus information on finding difficult items and a few problem items to source.

Camden Books

In most cases, to purchase a technical book first published at the beginning of the century would be to buy a book purely for historical reasons. This is far from the case with books relating to machine shop practice, in which, apart from a few safety aspects and illustrations such as lathes driven with overhead flat belts, the contents are very much appropriate to today's methods in the home workshop.

I have seen two such books recently, the first being *Milling Machine Kinks*, originally published 1908. This is an A6 size pocket book of 100 pages dealing with milling practices. Being of the era that it is, it illustrates mainly horizontal milling. Much of this however is equally appropriate to vertical milling. It is widely illustrated with excellent line drawings. Subjects covered include positioning the workpiece, cutting racks, boring an ellipse and many others. At £4.95 + 65p p&p it would appear quite pricey, but then how does one judge value for money on something like this. Just one useful idea from its pages will more than repay the expenditure.

The second book is something quite different, this is *Advanced Machine Work* originally published in 1925. The book is hard cover bound and about A5 size, at first it would appear to have in excess of 1500 pages but closer examination shows this to

be 797. This situation is due to what the book says is the use of a patented method of page numbering. Illustrations are by line drawings, of which there are 886, this is preferable as essential details are so often lost in the shadows of published photographs particularly those in books of this age.

The intention of the book is well described from the inscription on its first page, this states "Prepared for Students in technical, manual training, and trade schools, and for the apprentice and the machinist in the shop". It is quite impossible in the space available to describe in detail the contents of the book. It is divided into 15 sections, hence the patented page numbering, of which six are on the lathe, five on other machines including cutter grinding, the remaining are on gear cutting, tool making and two on measuring and inspection. The last two cover the use of micrometers, verniers, gauges and much more. Also the installing and setting up of machines for accurate working.

The book is very easy to read and there is hardly a page without one of the excellent line illustrations. At £22.90 inc. p&p this is genuine value for money. Please also see my comments in *On the Editor's Bench* regarding the two books which are available from Camden Miniatures Steam Services, 13 High Street, Rode, Somerset BA3 6NZ. Tel. 0373 830151.

QUICK TIP

Keep a couple of large tin lids (ie biscuit tin size) in the workshop. They're very handy when tipping out that jar of assorted wim-wams to find what you want. You can spread them in the lid to make your selection without them escaping across the top of your bench, and it's easier to get them back into the jar afterwards.

Fettler

Workshop videos

A range of videos on workshop related practices are available from SPS Audio Visual. These were originally intended for use in education and each runs for around 10 to 12 minutes. Prices are £7.00 + VAT + postage. Postage is £2.50 + VAT per video. See also *Scribe a Line*.

Titles available include: *Preparing a sand mould for aluminium casting; Casting aluminium; Vacuum forming plastics; Manual metal arc welding; Metal inert gas welding; Wood turning between centres; metal turning using a lathe; Heat treatment (hardening and tempering)*. For a complete list send to SPS Audio Visual Ltd., 27 High Street, Inverkeithing, Fife, KY11 1NL. Tel. 0383 416033.

Change of address

J.A. Crew & Co. frequently mentioned in articles as suppliers of materials, has a new address, this is now J.A. Crew and Co., Watery Gate Farm, Chipping Campden, Gloucestershire GL55 6QU. Tel. 0386 841979. Their range of items includes materials, tools, bearings, fastenings, plus electrical and electronic components. For a copy of the latest catalogue send £1.00 in stamps. Items are sold by mail order only, no callers.

Female live centre

Machine Tool Sales, the makers and suppliers of the well known Matosa live centre, are now offering their recently introduced female version at a special price. The centre is available with Morse tapers sizes 1 to 4, and a choice of mouth diameters, $\frac{1}{16}$ in., $\frac{1}{8}$ in. and $\frac{1}{4}$ in. each coned at 60 deg. inc. For details, send to Machine Tool Sales, Sparks Lane, Cuckfield, Sussex RH17 5JP. Tel. 0444 242266. Visitors by appointment only.

Sources of supply and services

Some more suggestions sent in by readers.

QUICK TIP

File 'Pinning'

Rub the end of a piece of aluminium rod sideways along the teeth of a file that has become clogged or 'pinned'. The file will cut the aluminium to its tooth profile as cleaning proceeds. This is far less damaging than using the old traditional 'carding' or a wire brush.

Fettler

Tool grinding

Scorpion Tooling Services, Unit 9, New Mills Ind. Estate, Libby's Drive, Slad Road, Stroud, Gloucestershire GL5 1RN. Prices typically £1.00 for a slot drill up to $\frac{1}{2}$ inch. Send a SAE to the above address requesting price list. A comprehensive range of second hand cutters also available.

Non ferrous castings

Highly recommended by a reader for personal service, Mr Dick Bonser, Thos. Saniford Ltd., Liley Street, Rochdale, Lancs. OL16 2AR. Tel. 0706 46168.

A useful book

Precision Grinding Techniques, Ref. PG8 (includes cutter grinding). Obtainable from Jones and Shipman plc, Narborough Road South, Leicester LE3 2LF. Tel. 0533 896222. Price £5.00 inclusive of post and packing. Send order to above address, marked for the attention of Mr M. Wright, Publicity Dept. Make cheque payable to Jones and Shipman plc.

Readers requirements

This feature has been found to be quite time consuming when considering the number of readers who benefit. Also coupled with the fact that *M.E.W.* is published two monthly and has a long production cycle, this makes it slow to bring results. In future please send your requests, as briefly as is possible, and they will be considered for *Scribe a Line*. Here are a few outstanding requests.

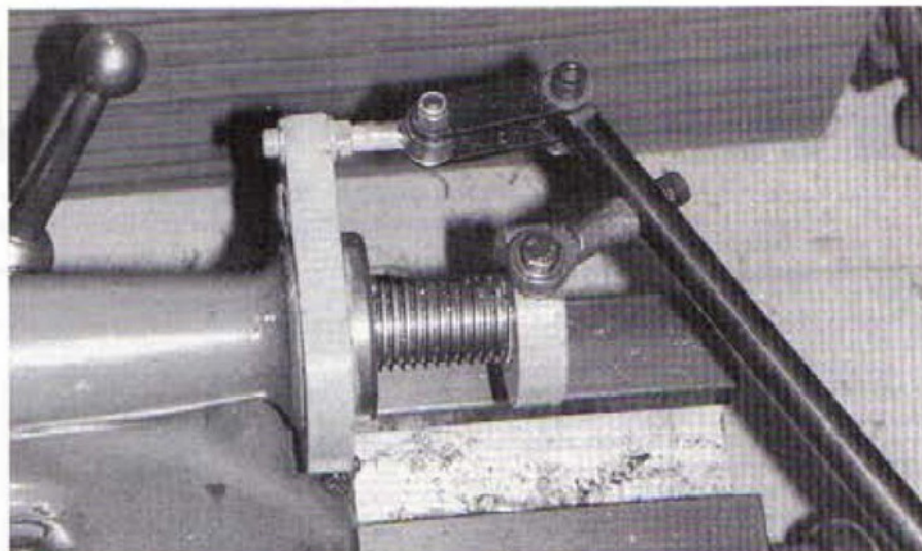
1) **Brass.** A supplier of brases, other than the common C2121, in particular bending quality rod C2109.

2) **Clinometer.** A reader requires an ex-government gunsight clinometer, or similar. Does any reader have one surplus or know of a source of supply?

3) **Spring wire.** A reader has a very specific requirement for a small quantity of 0.005in. steel spring wire, must be 0.005 inch. Has any reader a small quantity surplus?

This is the tool as made by the Author. It will be apparent from the photograph that he has used commercially available "Banjos" as his pivot points.

For some work for example sensitive drilling, it was found that the screw fed tailstock supplied had limitations. This quickly made accessory by Mr. Coe, takes care of the problem without damaging the lathe.



ML7 TAILSTOCK LEVER FEED

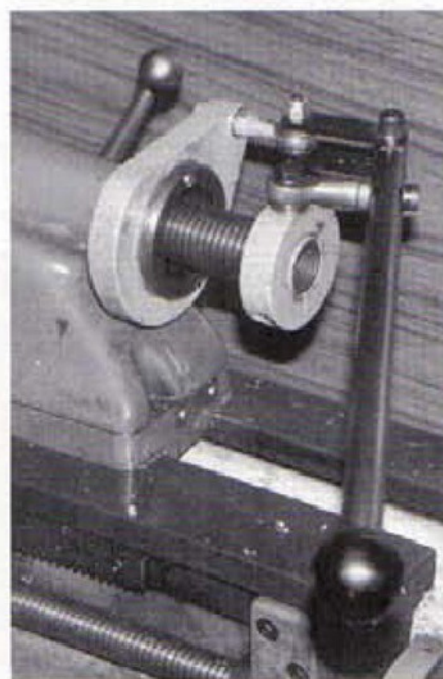
Finding the screw operated tailstock feed left something to be desired, particularly when used for drilling operations and the like, it was decided that producing a lever feed mechanism was worth considering. The lathe that required the mechanism was a Myford ML7, I refrain from using the phrase "lathe to be modified" as I considered it preferable that no changes were to be made to existing components.

The design that eventually surfaced is that seen in the two photographs. Removal of the tailstock hand wheel is accomplished by removing the single screw holding the plate making the wheel captive. With the screw and plate removed the handwheel can be unscrewed from the thread on the barrel, the plate and screw can then be returned to the tailstock, only the handwheel requires to be stored away for use as required.

It is now possible to clamp onto the large diameter at the outer end of the tailstock a part to anchor the fixed end of the mechanism and to clamp onto the outer end of the threaded barrel something to take the moving end. These two components amount to the major part of the work involved in making the attachment.

Fixed clamp

Considering first the fixed clamp, this is dimensioned as bored 2 1/4 in. diameter, the diameter will probably have been constant throughout the life of the ML7 but it would be wise to check. The shape of this component makes for quite an amount of work, much of which is for appearances sake only. Anyone with a milling machine and a rotary table will not find this too daunting, otherwise it is a case of the hack saw, or band saw if available, and some considerable effort with the file. This may



Looking down on the unit, note the use of the Nylock nut on the inner of the securing bolts on the swinging link.

be a good exercise in the use of such items, but if more interesting projects are on the table it may seem a little unnecessary. In this case the part could be made purely rectangular, that is 3 x 3 1/4 in. and with the corners liberally removed both for appearance and comfort in use.

If the clamp is left in rectangular form it may not be sufficiently flexible to permit it to clamp securely, in this case some additional saw cuts will be required. To improve the appearance these can be made from within the bore, going towards

the outside, rather than the more obvious way of from outside and towards the bore.

The clamp should be clamped to the faceplate for boring with a little packing; maybe a piece of thin card, to avoid as far as possible the faceplate being damaged when the boring tool breaks through. As the tailstock is not required, other than drilling the initial hole when boring commences, it can be removed and used as a gauge when finally making the bore to size. The remaining operations such as drilling, tapping and slitting are all very straightforward and require no explanation.

Moving clamp

The moving clamp is simple, being made from a piece of 2 in. diameter steel or aluminium, again the tailstock barrel can be used to gauge the final bore diameter.

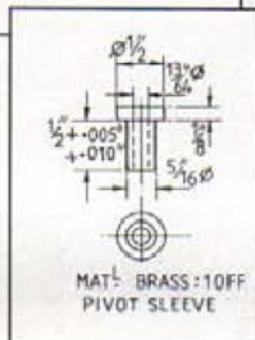
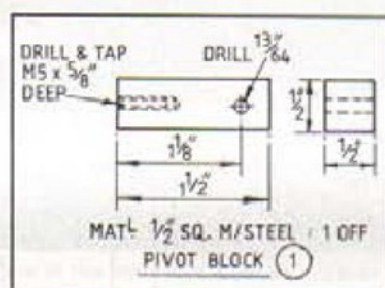
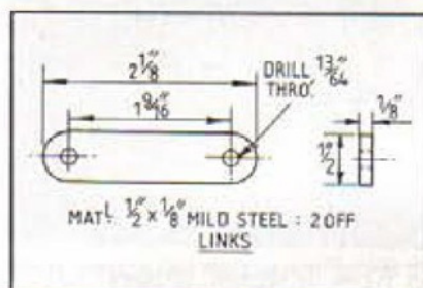
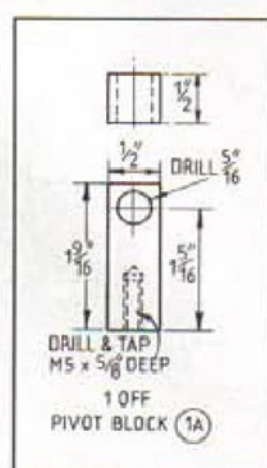
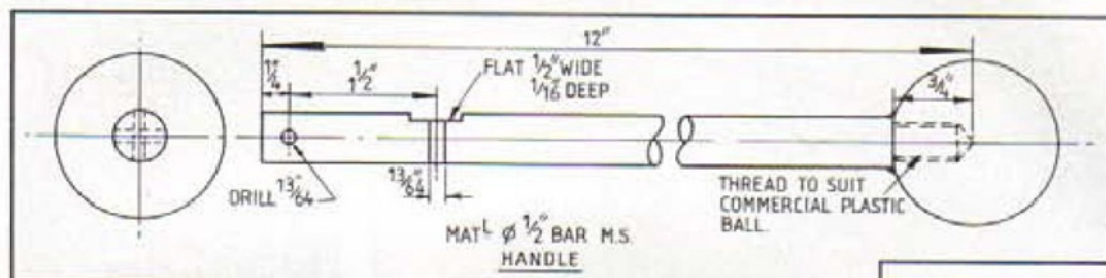
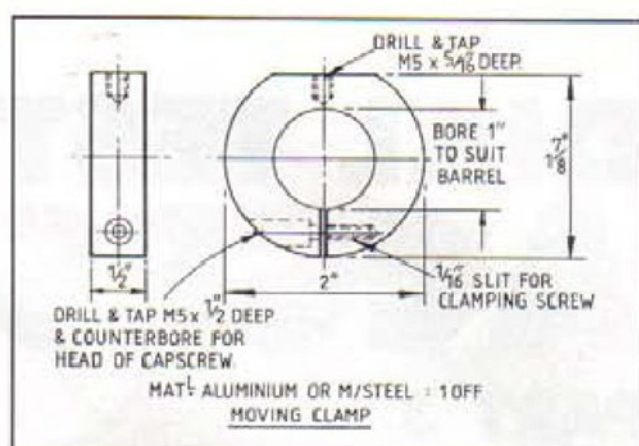
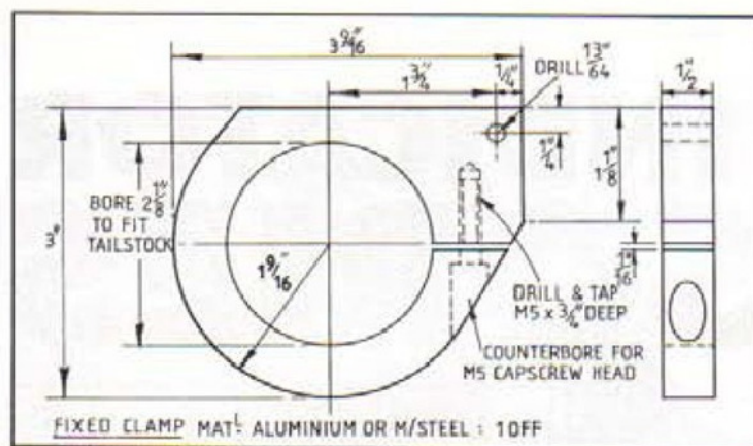
Remaining parts

No explanation is required for the remaining parts, but reference to the photos will show that the two pivot blocks, parts 1 and 1A were shaped on the original, as drawn these are shown made from 1/2 in. square material and left in that form to minimise the work involved.

If a plastic ball is not available, then a metal piece, say 1 in. diameter and 2 in. long, could be made with round ends, this being drilled and tapped for fitting to a suitable threaded portion at the end of the handle.

Assembly

When assembling, a little Loctite on some screws will make them more secure, but the screws either end of the two links will require Nylock nuts, or nut and lock nut, so that they can be adjusted to leave the joints just able to pivot freely.



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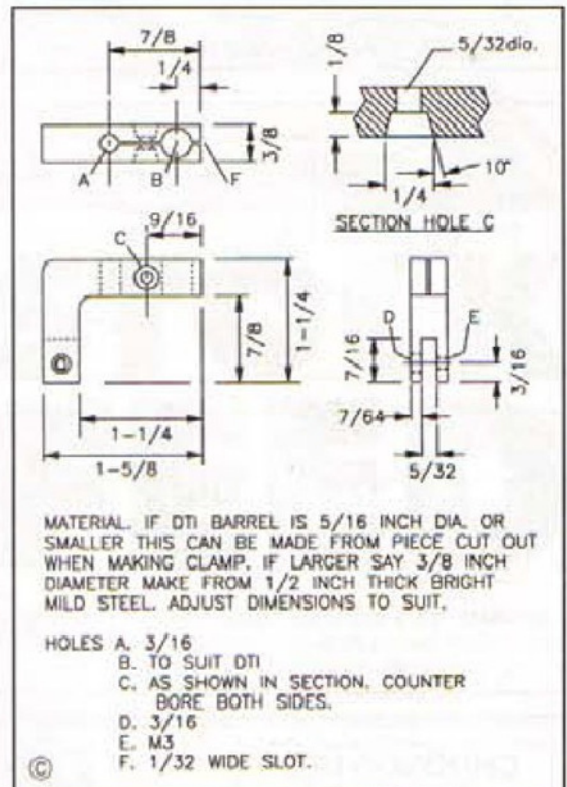
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DIAL TEST INDICATOR ACCESSORIES

PART 3



The accessory fitted with the straight arm and with the alternative right angle arm.



We conclude the series on making dial test indicator cum helping hand accessories, with this short item on making an inside attachment.

In the previous two issues a wide range of items have been detailed for the mounting of a dial test indicator, and for expanding the use of these into what has been dubbed, for want of a better title, (*any other offers, Ed?*) a Universal Helping Hand. The series now concludes with an attachment for mounting onto the D.T.I., enabling it to be used to sense internal and obscure surfaces. I am however, confident there is still much scope for extending its use.

The design conforms to a well established idea, and for most readers may be a superfluous item to publish. As the piece of metal just happened to appear when making the G clamp in the last issue, it seemed right to include it. In any case no doubt there are those readers new to the hobby for whom the idea is new.

One of the main purpose of this item, is for sensing the inside of bores running in the lathe. It can of course be considered for use in any situation where the normal dial test indicator is unable to gain access. The device can also be fitted with a right angle arm, this will further increase the range of applications in which it will be helpful.

Accuracy

When fitted with the accessory the D.T.I. will invariably be less accurate, for unless both ends are the same distance from the pivot some error will result. This is likely to be more of a problem with the right angle arm, however in most cases the tests will be comparative, so errors will be of little significance. Where actual dimensions are being read this possibility must be considered.

Manufacture

Providing the barrel on the D.T.I. is of small enough diameter to permit the use of the right angle piece already available from the clamp made earlier, proceed with this. If not, a piece must be cut from thicker material and the dimensions adjusted to suit. Take the angle piece and finish machine over the already machined surfaces, remove all sharp corners and drill and tap all holes as shown in the drawing. Take note that there are tapered holes on both sides; the reason for this is that it will permit the clamping nut to be fitted on either side. Due to the confined spaces in which the attachment may be used, this facility may prove beneficial.

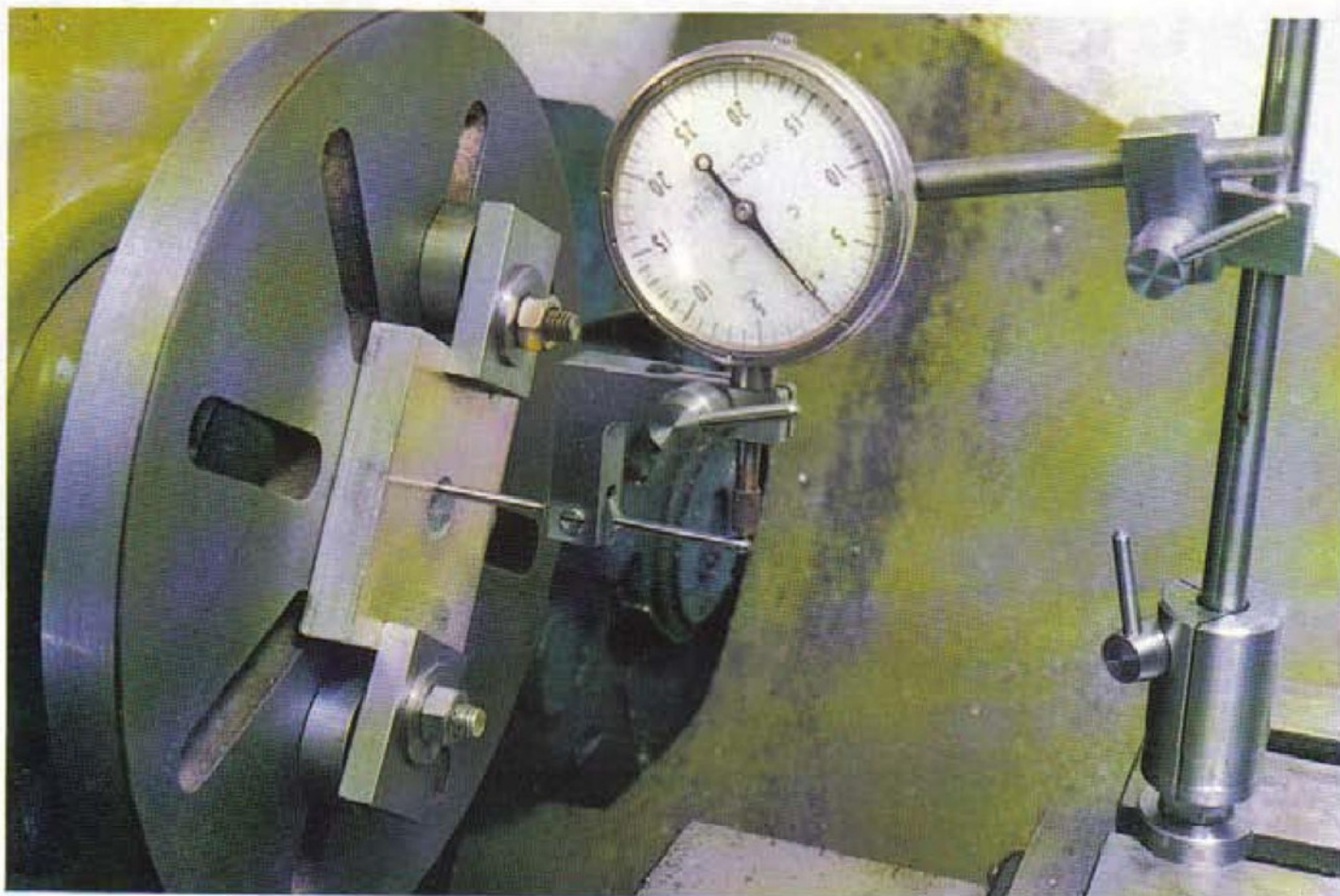
Set up the milling machine to produce the slot for the arm, the arm will eventually be machined to be a close fit in the slot, so the slot's width is not too critical. The slot to create flexibility for clamping can be

done with a hacksaw if approached with care, otherwise, if preferred, the milling machine can be set up with a slitting saw and the operation carried out using this.

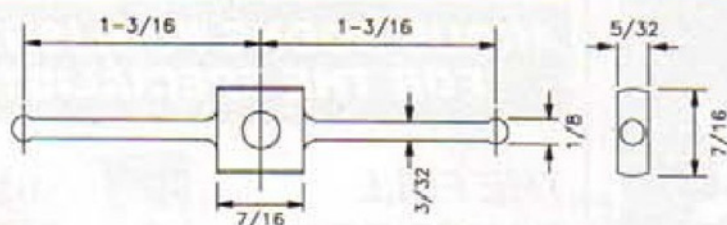
Straight arm

First cut a length of BMS about 2 1/2 in. long. Place in the lathe and turn a short length, say 1/2 in. to 3/4 in. diameter. Then using a round nose tool reduce the diameter to 1/2 in., leaving the short section on the end still at 3/4 in. diameter, from which the ball is to be created. With care make the ball on the end using a small fine file. follow this by turning the 3/4 in. diameter over the full length required. Turn the part round in the lathe and produce the other end of the arm in the same way.

Remove the arm from the chuck and set up vice and small end mill in the milling machine. Fix the arm in the vice ensuring that the two ends are at the same level; a suitable width parallel placed in the vice and the central portion of the arm resting on this should achieve this aim. Now mill flat on one side to the required depth of 1/4 inch. Remove from the vice and measure, with a micrometer, the thickness between the curved side and the flat face just produced. Having also measured accurately the width of the slot made in the right angle piece, the amount to be removed from the second side, such that it become a close fit, can be calculated.



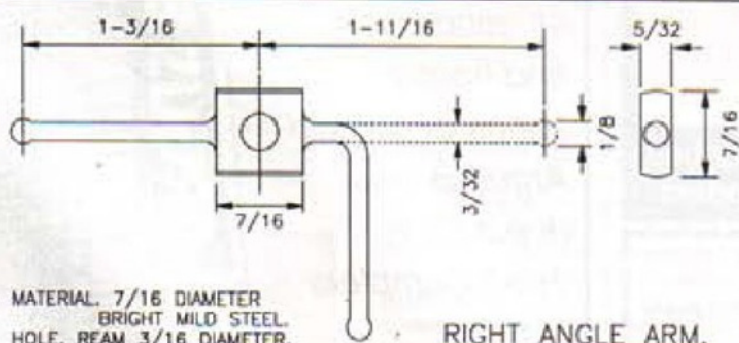
Being used to test the concentricity of the bore in the plate mounted on the face plate, with that of the lathe spindle.



MATERIAL. 7/16 DIAMETER BRIGHT MILD STEEL.
HOLE. REAM 3/16 DIAMETER.

STRAIGHT ARM.

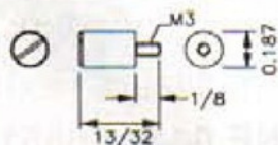
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MATERIAL. 7/16 DIAMETER
BRIGHT MILD STEEL.
HOLE. REAM 3/16 DIAMETER.

RIGHT ANGLE ARM.

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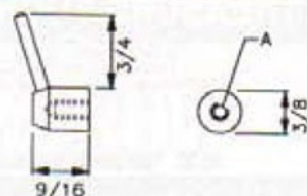
MATERIAL.
1/4 INCH DIAMETER
BRIGHT MILD STEEL.

PIVOT PIN.

©

Return the arm to the vice, curved side up, set the ends level, again using a parallel, and machine that side to the depth required. The amount removed should be such that it is around a thou, or two thicker than ultimately required. This will permit the final amount to be removed using a fine file, testing frequently until a close but free fit is achieved.

It is probable that the distance between the two balls at either end is not precisely 2 3/4 in. as in the drawing, this is not important as the actual dimension is not critical. What is far more important, is that



MATERIAL.
7/16 dia BRIGHT MILD STEEL.
1/8 dia BRIGHT MILD STEEL.
HOLE A M4 X 3/8 DEEP.
SHAPE GENERALLY AS SHOWN.
FIX ARM USING ADHESIVE.

CLAMPING NUT.

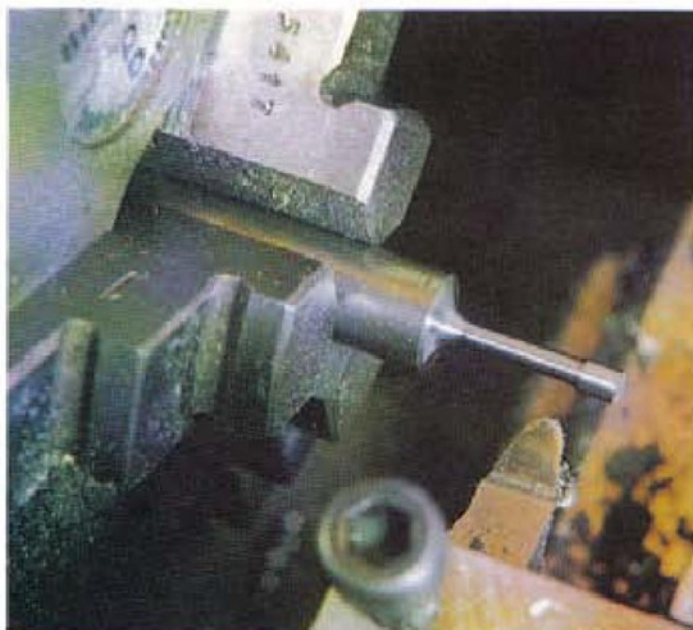
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MATERIAL M4 X 12mm HEX HEAD SCREW.
OR 1/4 dia BRIGHT MILD STEEL.

CLAMP SCREW.

©

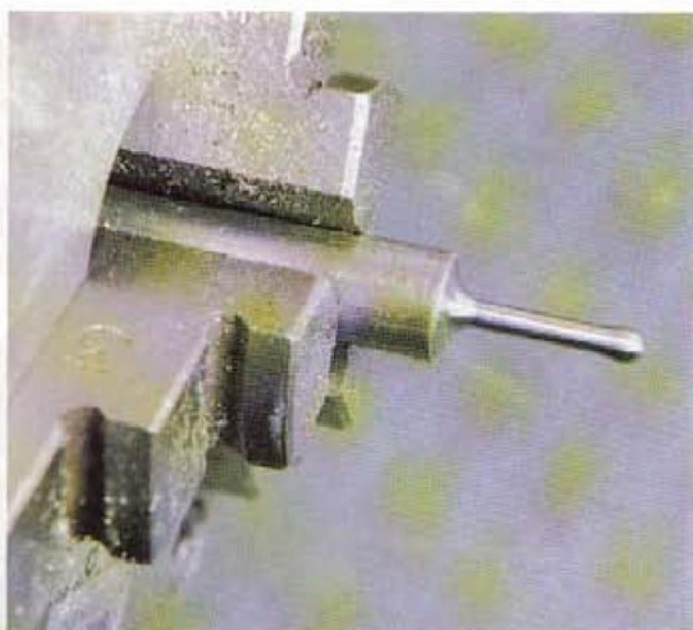


The first stage of turning the ball on the end of the arm.

the hole is central to the ends as accurately as can be established. Measure the distance, and from the value calculate, then mark, the position for the hole. As two arms are to be used, both to pivot on the same pin, it is essential that both holes are the same size. Drilling first with a $\frac{1}{8}$ in. drill followed by a $\frac{1}{4}$ in. drill will help to ensure both holes are the same size and reasonably parallel. Ideally it will be much better to use a $\frac{1}{4}$ in. reamer if one is available.

Right angle arm

Make this generally as the straight arm, but with one arm longer than the other as per drawing. One dodge however will be to reduce the arm diameter to about $\frac{1}{8}$ in. for a length of $\frac{1}{8}$ in. at the point where the bend is to be made. This will permit the bend to be made easily by pulling the arm, by hand, round a $\frac{1}{8}$ in. diameter piece of steel held in the vice. The narrow waist will



After creating the ball end, using a small fine file.

ensure that the bend is confined to that part of the arm.

Small parts

Turn the pivot pin from a piece of $\frac{1}{16}$ in. diameter steel such that it is a close but free fit in the two arms, otherwise little is required to be said regarding the smaller item. The clamping screw and nut are made as those for the previous assemblies.



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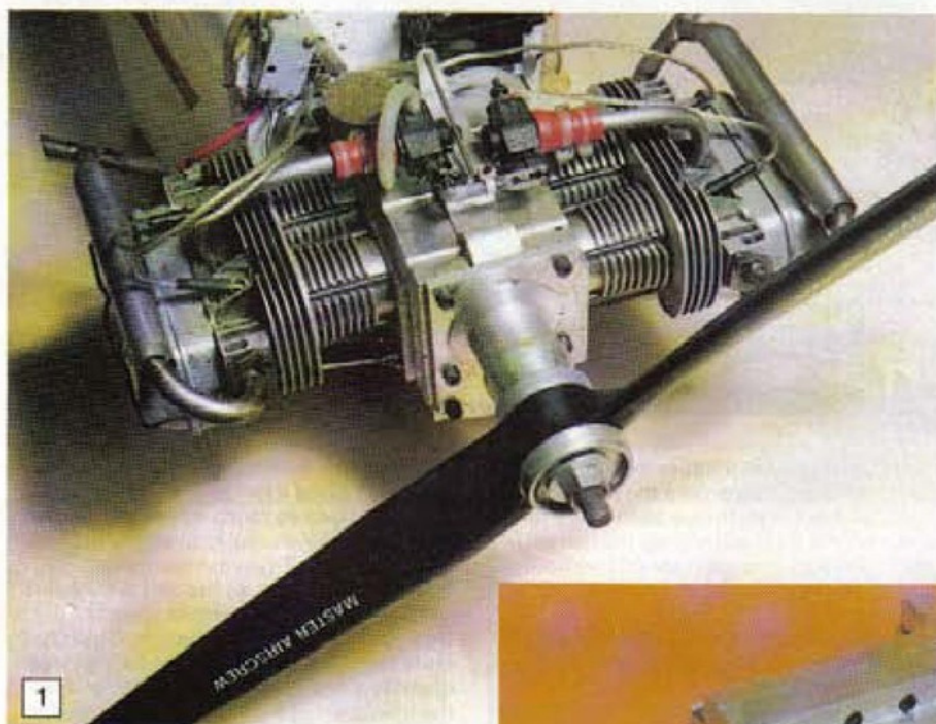
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A LOOK AT DEREK BROOKS' WORKSHOP



After many years of making and flying large model aircraft, Derek Brooks decided to enter the field of model engineering by making his own 4 stroke 4 cylinder i.c. engines. Not content with such projects, he also designs and makes some equally ambitious items of workshop equipment, as is evident by the Tool and Cutter grinder article which also appears in this issue.

Derek Brooks' entry into the realms of a home machine shop owner, came about as a result of a desire to make his own engines for the model aeroplanes that he had been making for many years. His interest in model aeroplanes goes back to around 1950, for many years he flew these using engines purchased from commercial sources. The planes that he has made are very much in evidence in his workshop, and in his garage, which also houses some workshop equipment.

Two metre wing span

These planes are quite large, mostly having some 2 metre wing span; because of this the planes are stored with wings separated from the fuselage. Two helicopters are also in evidence. The planes are radio controlled and Derek talks about the early days when making the electronics was all part of the exercise. Now, with the considerable advancement of electronics,



and also the hobby, it is impracticable to attempt to compete with the commercially available units. This fact is evident in the change of emphasis that has occurred over the years in the pages of *Radio Control Models and Electronics* which he has, spanning from 1960 to the present day. Earlier issues had a considerable electronic constructional content, which is much less in evidence in present day issues.

A typical transmitter will cost around £300-00 and contain the equivalent of a small computer, enabling the transmitter unit to be programmed to contain the characteristics of more than one aircraft. If then instructed as to which plane is to be flown, it will adjust the parameters so that flying the plane is made as effective as is possible.

Entry into machine shop activity

Derek's entry into machine shop activity came about 1978 when it was decided that as well as making the aeroplanes, he would also make his own engines. If you are considering that we are talking about the small single cylinder engines very much in evidence in smaller model planes, this is not the case, the engines are four stroke, four cylinder with a capacity of about 20cc.

Derek's first effort was to make a 1/4 scale model of the Volkswagen Beetle engine, as seen in **photograph 1**, this may seem an odd choice. It is however a logical one, as being naturally air cooled, rather than water cooled, it is apparently very popular as an engine for use in small light aircraft. Being 1/4 scale by length its capacity is 1/64th



of full size, ie $\frac{1}{8}$ cubed, however, power does not, according to Derek, scale in the same way.

There are no castings available for these engines and therefore all parts are made from the solid. This requires a considerable amount of machining work on such items as the cylinder and engine blocks. There are no working drawings available, parts are therefore scaled down from an old full-size engine which he owns.

A second engine, and the one in construction at the moment, is a Rolls Royce Continental, this being an engine which was designed primarily for use in small light aircraft. Examples of the parts being made for this are shown in **photograph 2**. Of particular interest in this photograph is the split crankshaft, note the half bosses at the split which enable the bearing shown to be fitted in the middle of the crankshaft assembly.

His own design tool and cutter grinder

Elsewhere in this issue there is an article on a universal grinder which Derek has developed and made. Whilst this is primarily intended as a tool and cutter grinder, its adaptability has enabled him to grind such things as carburettor needles and engine valves. Examples of the valves can also be seen in the front of **photograph 2**, these being about 1in. long. **Photograph 3** shows the twin carburettors for this engine.

Readers who have commented on the lack of basic machine shop activity in industry these days, and consider as a result that there will be few to continue the



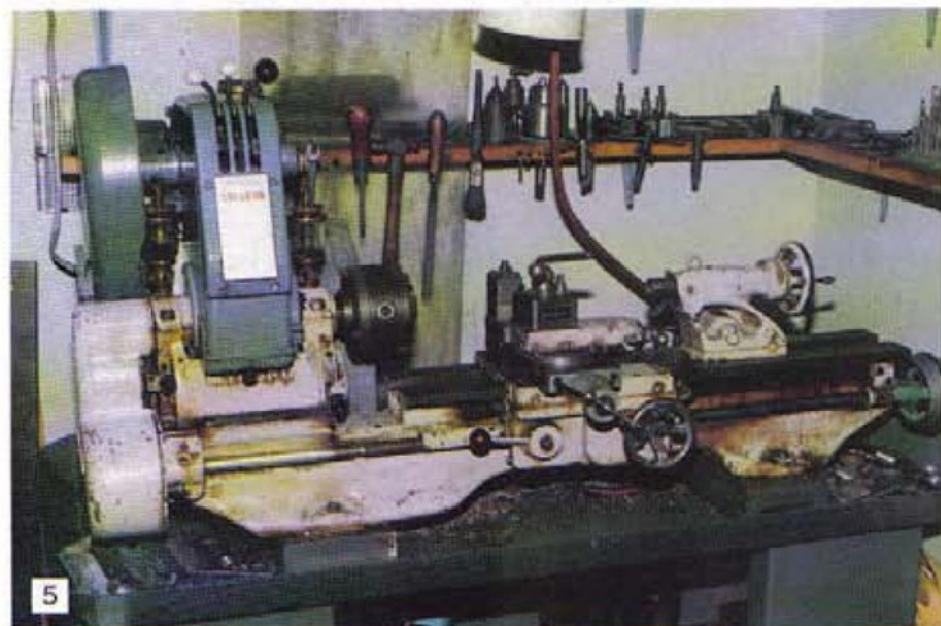
will be published in a future issue. He is very enthusiastic regarding the machine and points out such things as the very long stroke on the quill, permitting the use of centre drill and much longer drill without the need to raise the head and lose registration.

On first entering his workshop, Derek referred to his universal band saw, stating

photograph 6, which together with the back gear gives a range of six speeds. This feature is liked so much by him, that when an older ML7 was replaced by the present newer one, the Tri-leve system was interchanged between the two lathes.

The arrangement permits speed changes to be made on the run, which he finds particularly useful when facing large diameters. Whilst the machine is running the operation of a lever will automatically disengage the one being used, however if two levers are operated simultaneously whilst the motor is stationary, it can be used to lock the mandrel. The Tri-leve arrangement was only available on the original ML7 lathes, and can no longer be obtained, even as an add-on attachment.

Derek's bench grinder can be seen in



various hobbies of home machine shop owner, should take heart. Derek is an excellent example of one who has had no formal engineering training, and yet can complete the design and manufacture of some excellent and involved work.

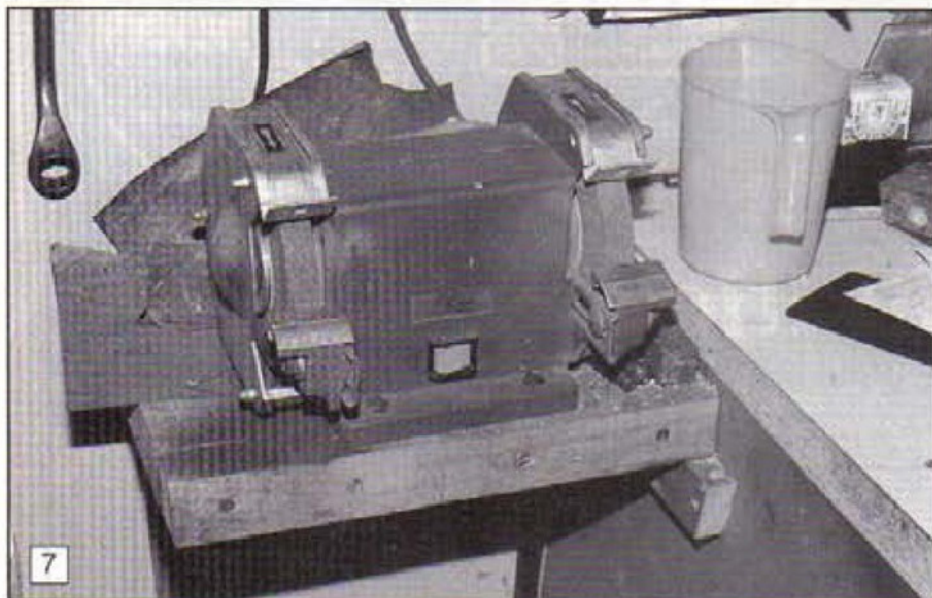
Another of his successes is the Dore Westbury milling machine, seen in **photograph 4**. He made this from a kit of part machined parts which is available from Model Engineering Services (tel 0246 433218). Derek amazingly completed it in two weeks, he does admit to burning a lot of the midnight oil to achieve this. A brief account of his experiences in making this

how beneficial it was. This was interesting, as almost the first words from Albert Wallis, featured in a recent readers visit, were also to speak highly regarding the benefits of owning such a saw. (There is in the trade pages of this issue, a review of one of these saws - Ed.)

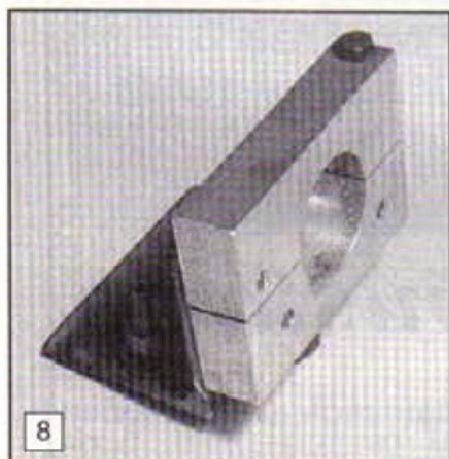
ML7 with Tri-leve

Derek's other major item of workshop equipment is his lathe, being a Myford ML7, which can be seen in **photograph 5**. This is fitted with the Tri-leve method of speed control, seen in close up in





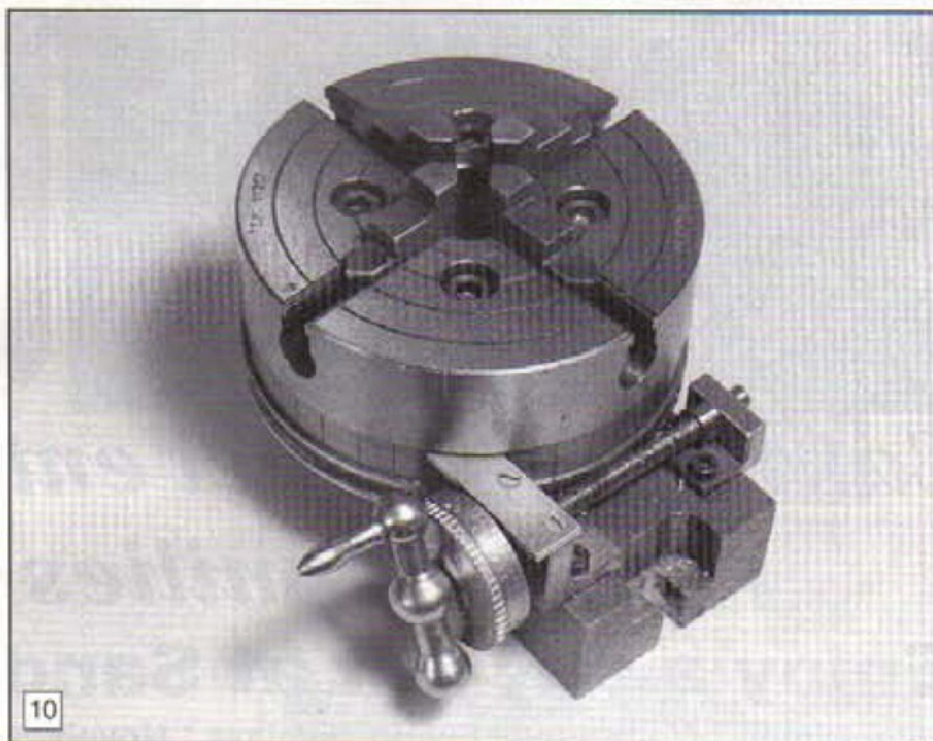
photograph 7 and it is worth noting that he has this mounted on a quite thick piece of wood. This is always a good approach when mounting a bench grinder, as the thick wood can be very effective in damping out vibrations.



Putting his designs on paper

An example of his methodical approach is the inclusion in the workshop of a large (A1 size) drawing board. Derek rarely approaches any project, other than the very simplest, without first putting pencil to paper. Being in the workshop is particularly advantageous, as it enables both component and drawing to be kept in line when modifications are required during the manufacturing stages. It also enables availability of suitable materials to be easily checked during the design process. I feel that many, myself included, will create their drawings in the greater comfort of the house.

There is evidence of many items of workshop equipment having been made in the workshop. These range from the very large, such as the cutter grinder detailed elsewhere in this issue, to the very simple pistol drill mount seen in **photograph 8**. This is used to mount a pistol drill onto the lathe cross slide, particularly useful when drilling holes on a pitch circle diameter. When doing this it is likely that another item of equipment he has made will be brought into use, this his dividing attachment seen in **photograph 9**. This item can be seen in the cutter grinder



article, being used when marking one of the micrometer dials.

Another of Derek's items that he has made is seen in **photograph 10** is his rotary table. The worm wheel has been made using a tap as a hob, and for those not familiar with this operation, it is done as follows.

The tap is placed in the lathe chuck whilst the wheel is placed onto a spindle mounted on the cross slide, the wheel is arranged to be able to rotate freely. With the tap rotating, the wheel is fed up to the tap, when the wheel will also start to rotate. As the teeth gradually form, the wheel is fed deeper into the tap, and a wormwheel results. This is an easier operation than is probably envisaged, but the problem comes when attempting to get exactly the required number of teeth. This is particularly so for large diameters and fine threads. For large diameter wheels the tap may require to be mounted on an extension, it will also require supporting in some way by the tailstock.

Another interesting idea that Derek puts forward regarding this, is that by removing the jaws from the chuck the slots in the chuck can be used as tee slots. I am sure there will be some who will be horrified at treating a chuck in such a way, especially if it is the only four jaw chuck available. However I consider that providing the tee nuts are sufficiently long, and as wide across the tee as the chuck will allow, then no harm should come to the chuck, providing also that the nuts are not excessively tightened.

Glen Miller style music

Whilst Derek's interest in his workshop is considerable, he is not a single interest man. In addition to still making and flying model aeroplanes, he is also leader of a Big Band, Glen Miller style I think. Seeing a rather elderly cornet hanging in his workshop I enquired whether he also repaired musical instruments, however this turned out not to be one of his activities.



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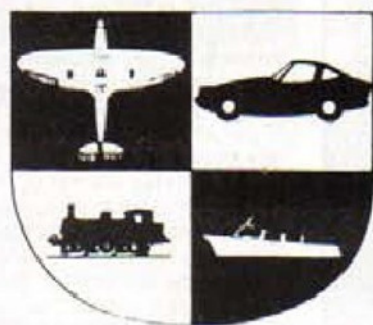
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ENJOY A MODEL STAY



A corner of the Exhibition, looking along one of the aisles, which was crowded with bargain hunters. This was the view of the exhibition seen from the balcony.

SEEN AT THE EXHIBITION

Just a few brief comments regarding the 1993 International Model Engineer and Modelling Exhibition held in the Grand Hall at Olympia, London, earlier this year.

Setting up a home workshop, in most cases, is quite an expensive exercise. We are fortunate, therefore, that the suppliers of machines do not continually bring out new models with which to tempt us to part with our money. Looking round this year's Model Engineer and Modelling Exhibition was, in respect of machines, much like previous years. Fortunately, this does not make it any the less interesting

for those with an interest in tools and machinery.

No doubt, if one studied in depth the content of the many tool suppliers stand, new items would be found, but looking for a new file or say a new angle plate, in the vast Olympia hall would be like looking for the proverbial needle in a haystack. As a result I concentrated on the larger items.

Small lathes

Considering what was on offer with regard to larger items, only the new small lathe, the Miniturn 200, from the Hobbymat people was to my eyes a brand new design. Even this has been available for a few months and was featured in the trade pages of the last issue, so will make no further comment regarding this. (CZ Scientific Instruments Ltd., Tel. 081 953 9456).

Another small lathe with a difference, is the Emco Unimat Basic SL. At first sight identical to the Unimat PC, it is in fact a simplified version, no longer having the provision for adding the stepper motors which are required if used in a CAD/CAM mode. Also some of the accessories are now optional extras. The result, a lathe in most respects the equal of the PC, but at a considerably reduced price. Seen on the Emco stand (Tel. 0923 250051).

Again another small lathe, this time one which is re-introduced into this country, apparently after a lapse of a few years. This is the Sherline 3in., a lathe of American manufacture and having been available there for a number of years. It can be had either with Imperial or metric calibrations. The speed range is 200 to 2000 rpm available by electronic control, motor power is not declared. Bed to lathe centre height is 45mm, whilst cross slide to centre height is 22mm, between centres 200mm. The design of the lathe is conventional, which cannot be said for the complementary milling machine from the same manufacture.



Seen on the Millhill Supplies stand, the Sherline lathe and milling machine.

A unique milling machine

The milling machine is probably unique, in that for such a small machine, the length of the table together with the movement in the three axis, particularly X and Z, are very generous. Spindle speeds are as for the lathe, actually having the same head and motor/speed control arrangement. Table size is 70mm x 330mm with a travel of 228mm. The head moves up and down dovetail slides so there is no problem with lost registration as is often the case with a round column. The vertical travel is 165mm.

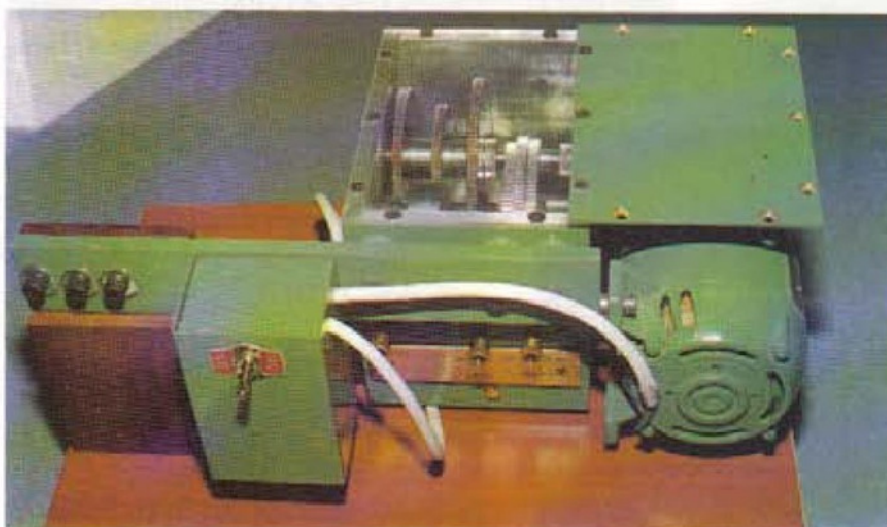
The throat depth of 50mm would however seem a little on the minimal side, especially in view of the generous nature of other characteristics. First impressions appeared to suggest that this could easily be increased by means of a raising block, another 20mm would improve the situation



A small high speed drilling machine, also on the Millhill Supplies stand.



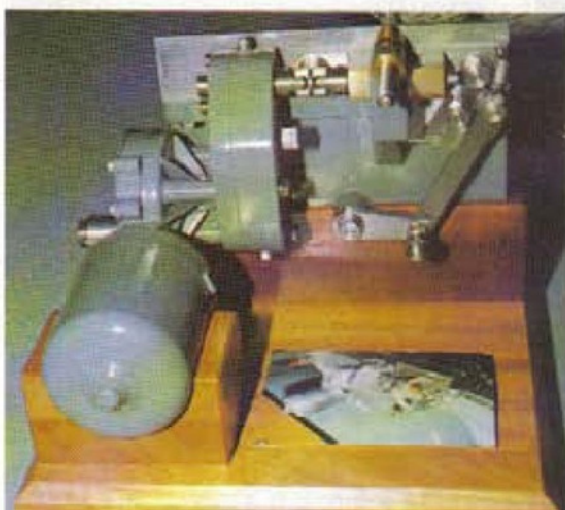
This rotary table, with accessories and the pattern used for the casting was displayed by Malcolm Leafe and gained a Highly commended certificate.



A very useful piece of workshop equipment, a 9 speed gearbox for the Myford VMC milling machine. It gained constructor Derek Brown a Very Highly commended award.



A 12 point rotary dividing fixture for second operation work on chuck mounted workpieces. Builder is Norman Shaw from Shefford, Beds.



This power cross feed for the lathe makes use of a car windscreen wiper motor. It gained a Silver Medal for constructor David Machin.



This is the actual Stent Tool and Cutter Grinder built by Doug English and recently serialised in our sister magazine, Model Engineer. Displayed in the Loan Section.

appreciably, the travel in the Y axis is 76mm. Both lathe and milling machine are reasonably priced and were displayed on the Millhill Supplies Stand (Tel. 0491 38653).

Millhill were also showing a small high speed drilling machine, which whilst similar to machines available from others, they consider to have a more realistic price.

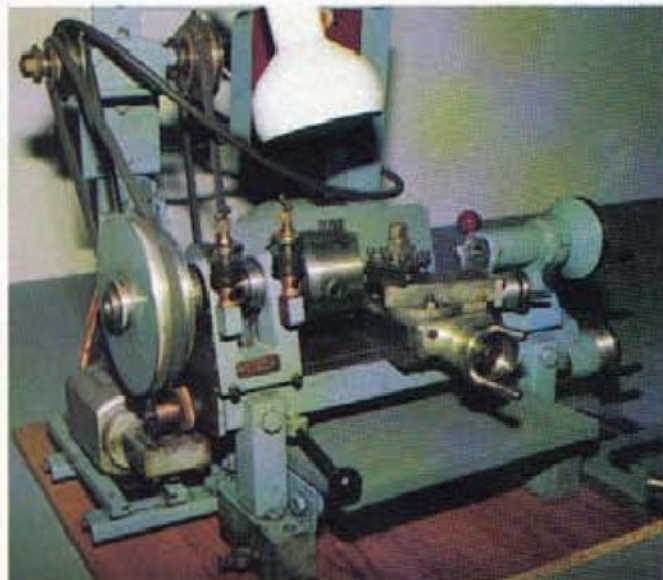
Competition entries

Finally a brief thought regarding the display of workshop equipment on the competition stands, again the numbers were small but some interesting items were to be seen. One item that did take my eye, and is shown in the photographs, was the Rotary dividing table exhibited by

Malcolm Leafe of Dewsbury. The interesting aspect of this to me was that he had obviously designed it himself, and as a result had made his own pattern for the casting which he also displayed, nice ideal. The exhibit gained a Highly Commended Certificate, this I feel backs up my comments in *On the Editor's Bench*. ▶



This rotary table, with low voltage power feed to the table was built by Geoff. Bartlett.



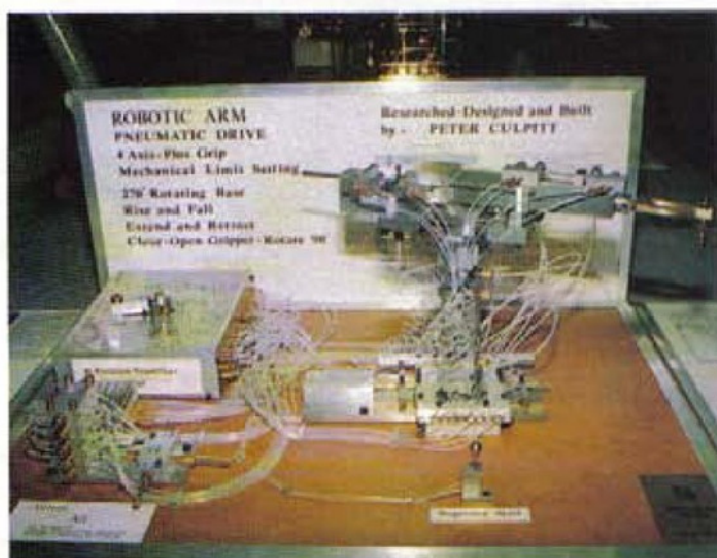
Another exhibit from the Loan Section, a small centre lathe built by Ted Norkett from Wellingborough. The machine is entirely fabricated.



A silver Medal was awarded to Dr. Peter Clark from Southwold for this series of workholding devices which he entitled The Awkward Chuck.



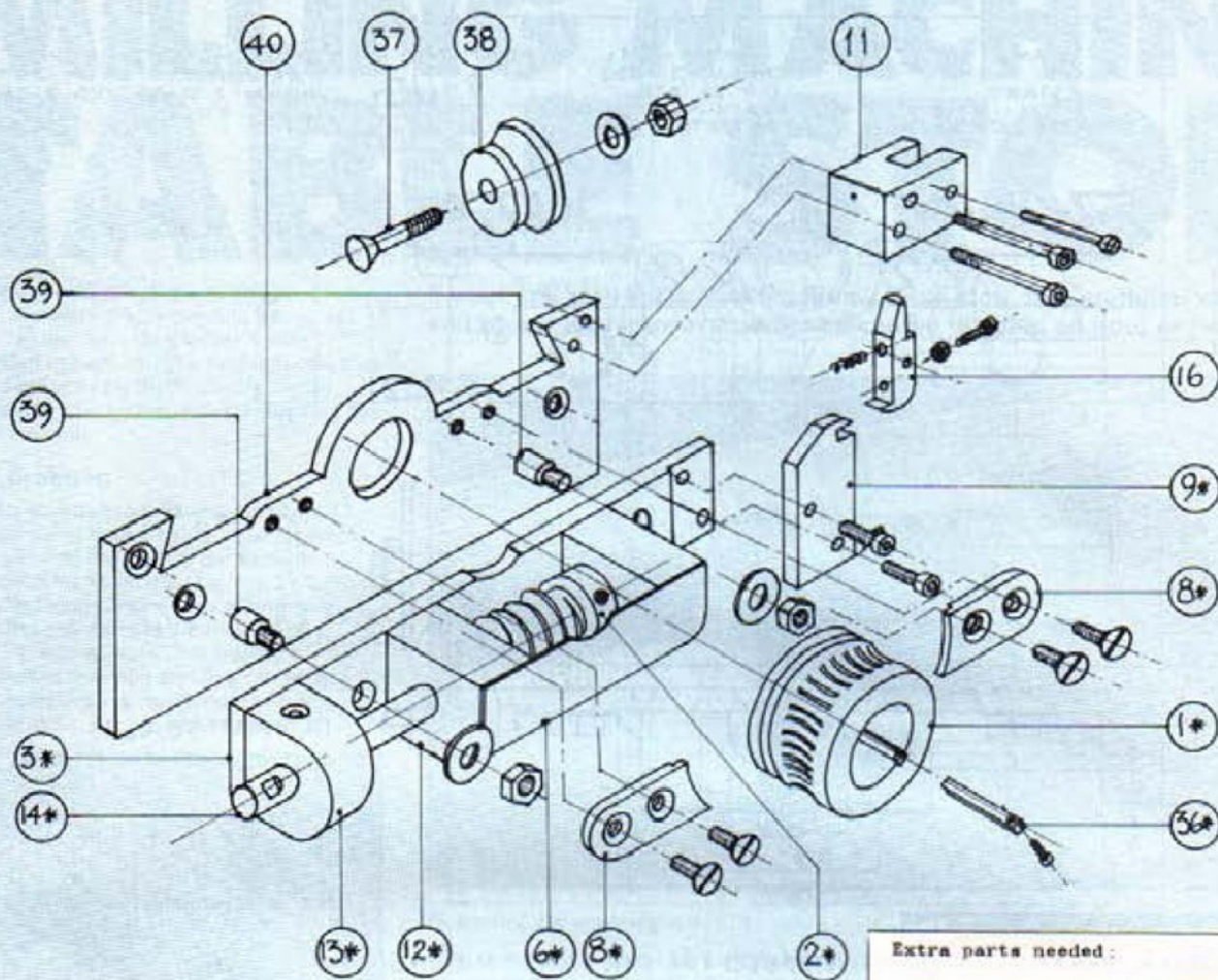
One for the ornamental turning enthusiast. This is a geometric chuck, made to fit a Myford or similar lathe. Builder is Paul Silvester.



This pneumatically driven Robotic Arm is a demonstration model, which was researched designed and built by Peter Culpitt. It gained a Gold Medal in Class A7. Modern thinking and excellent workmanship combined to make a really excellent exhibit.



First class finish and presentation, a Hand Rivet Squeezer made by Grahame Stothard from a design published in Model Engineer, shown in a nicely made wooden box.



STARRED ITEMS ARE SIMILAR TO, BUT DIMENSIONALLY DIFFERENT FROM, THE DETAILED PARTS DRAWN ON PREVIOUS SHEETS.

Extra parts needed:

Part	Description	Quantity
37	Auto stop cam bolt M.S.	2 off
38	Cam E.N.B	2 off
39	Pivot studs M.S.	2 off
40	Back plate M.S.	1 off

EXPLODED VIEW OF POWER FEED FOR FAR EAST MILLING MACHINES.

A POWER TRAVERSE FOR SMALL MILLING MACHINE

PART 3

David Machine, in the concluding part of this series, suggest ways of adapting this design for the Westbury milling machine table feed to enable it to be fitted to other makes of milling machine.

Now to discuss a version of the drive intended for the Far Eastern type milling machine. I have only examined one of these machines, (a Sealey) and the general arrangement drawing, is based on this. I assume that they are all basically similar.

However, I am conscious of the fact that I have not made a power feed for this machine, so I have not detailed those parts that are different from the Westbury version.

I would therefore strongly recommend that you measure up your own machine carefully to check that my General Arrangement is suitable. I have included some dimensions, but these do need

checking. The drawing shows an exploded view of the assembly, which would need fitting to the left hand side of the machine. Part 40, the backplate, is shaped and screwed to the cross slide. Note that the pawl block screws are long enough to be part of the fixings of the backplate. From there on, everything else is as already described, except dimensions.

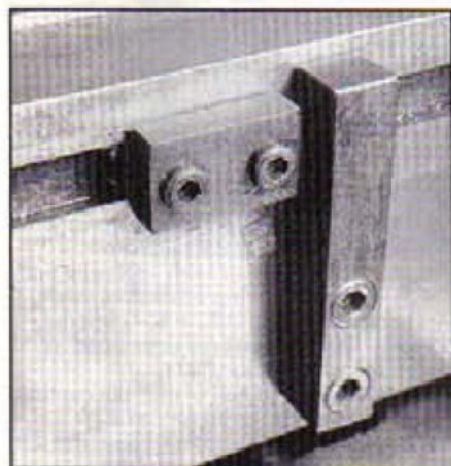
There would be no need for a new bearing bracket, but there may be some reduction of length of traverse. If you have access to another milling machine, the keyway cutting, along the original feed screw is as described, although the keyway size could be increased to, say, $\frac{1}{16}$ in. wide by $\frac{1}{16}$ in. deep. However, if you don't

MILLING MACHINE TABLE STOP

The fixed half of the table stop on my mill/drill was proving to be inadequate for the task it was intended to perform. The problem was that it was not very rigidly fixed and would move when hit by the moving stops on the machine table.

The problem

This was due to it having only two screws fixing it and, being close together, they allowed the vertical bar to pivot slightly. It was also made worse by the fact that the fixing screws were a long way from the point where the moving stop struck the fixed stop. This created a substantial leverage and this can be visualised in the arrangement before modification, seen in **photograph 1**.



Photograph 1. The original arrangement prior to modification.

The problem may be lessened by reducing the clearance over the screws but, due to their relative positions to the moving stops, the problem would be reduced by not eliminated.

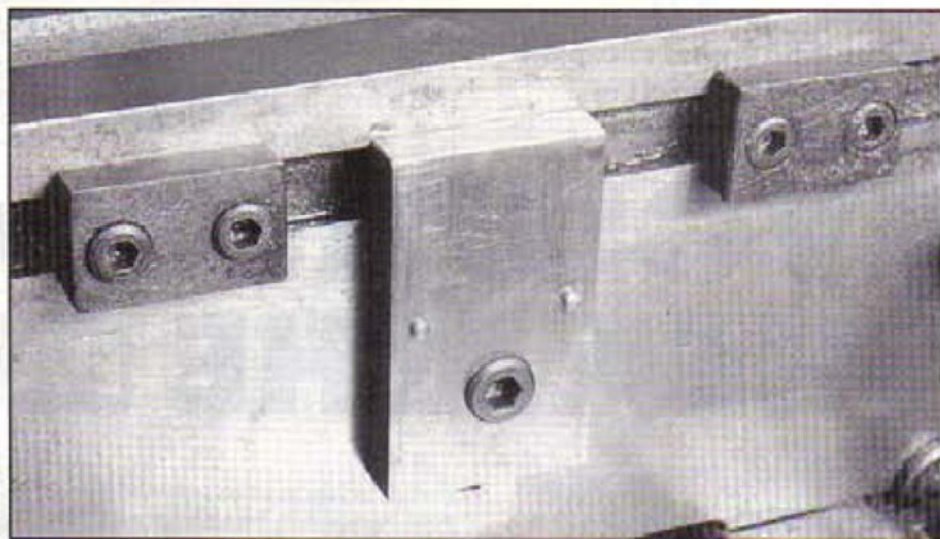
In the ideal situation, movement of the fixed stop should be eliminated. To achieve this the only practical method would be to use close-fitting dowels. Fitting dowels to the existing stop was considered; one could be fitted between the two screws and the other above them.

The solution

With this arrangement considerable leverage would still be applied to the dowels, and it was considered that it would be better if the dowels were more in line with the moving stops. To make this possible a new wider fixed stop was considered the answer, and the arrangement as seen in **photograph 2** was chosen.

For maximum effect the dowels are placed as high in the assembly as is practical. It was also decided to fix the stop using only the top one of the two screws.

If your mill/drill suffers with a flimsy table stop, this modified version will be a useful improvement, and can be made in an hour or two



Photograph 2. The new arrangement.

With these decisions taken, the fixed stop was made from a piece of $1\frac{1}{2}$ in. x $\frac{1}{2}$ in. bright mild steel and 2 in. long.

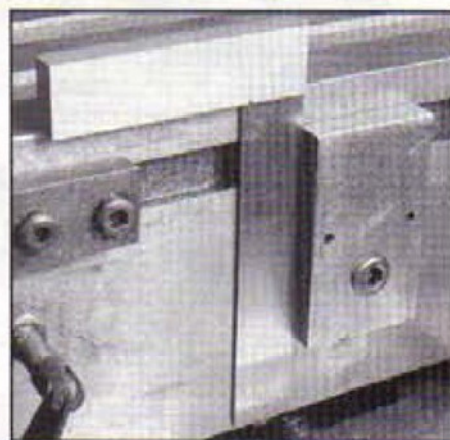
Any reader making this modification could make the part longer so as to still use two screws. In this case though, aprons were also being fitted at the same time, and the single fixing was beneficial to this modification. (This can be seen on page 29 of the Feb/Mar 92 issue. Ed.)



Photograph 3. New stop ready for fitting, note the relieved top half.

Photograph 3 shows the part ready for fitting. This is drilled with the one hole for the screw fixing and the two dowel holes. The holes for the dowels should be of a size suitable for eventually reaming to $\frac{1}{16}$ in. diameter. Also note that the top part is relieved by about $\frac{1}{16}$ in., this to enable the table to move past the stop freely.

Fix the part to the machine, using a square to position it correctly as shown in **photograph 4**. Fix firmly and drill through the dowel holes into the machine casting, drill to a depth of about $\frac{1}{2}$ in. Again use a drill size suitable for reaming $\frac{1}{16}$ in. diameter. Make two $\frac{1}{16}$ in. diameter silver steel



Photograph 4. Positioning the new fixed stop.

dowels and $\frac{1}{16}$ in. long. Ream one hole and fit the first dowel, following this by reaming for and fitting the second.

Looking at illustrations of other similar mill/drills, it would appear that an improved arrangement is now frequently fitted. Even so, from the design as it can be seen in the photographs, the addition of dowels through the existing stop piece would still seem like a good idea.

In use

When using the table stops for precision work, such as machining up to a step, the stop is used as a back-up only. In such cases the leadscrew dials should always be referred to for precise positioning.

This modification produced a usable table stop, replacing what was a totally useless feature of the machine as supplied, and was accomplished in a matter of an hour or two.



In the concluding part of this brief series Don Unwin provides us with a limited overview of the development of the lathe as it changed to meet the needs of the improved tooling and drive methods which have come about over the last century. There are several books and publications available to anyone who wishes to explore this fascinating subject in greater detail

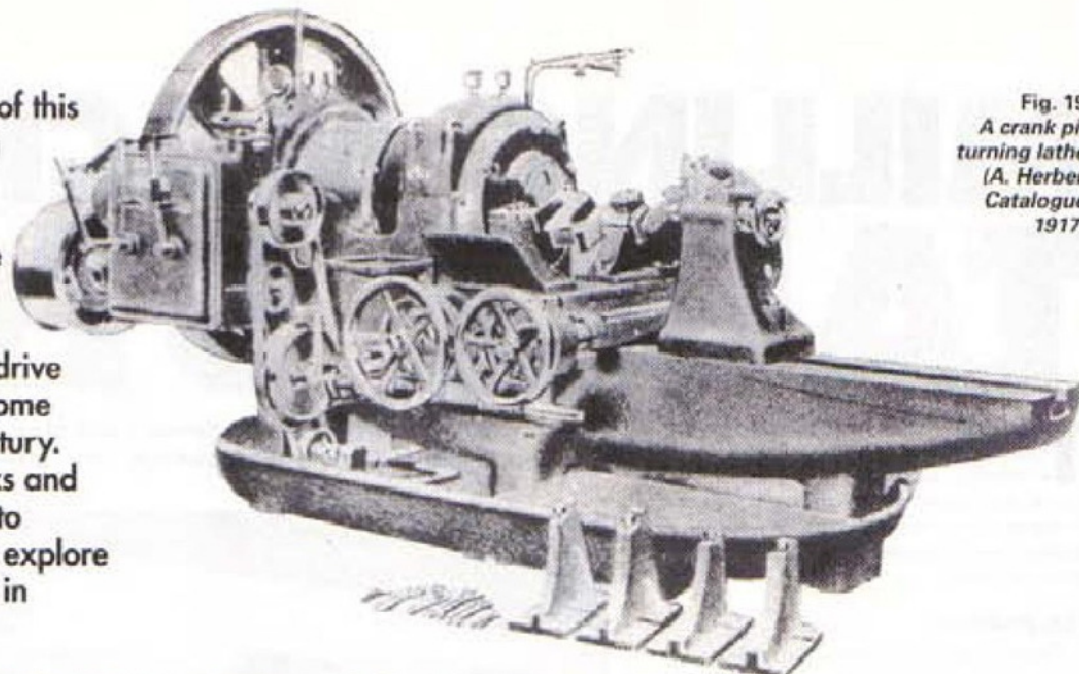


Fig. 19:
A crank pin
turning lathe.
(A. Herbert
Catalogue,
1917).

EVOLUTION OF THE LATHE PART 2

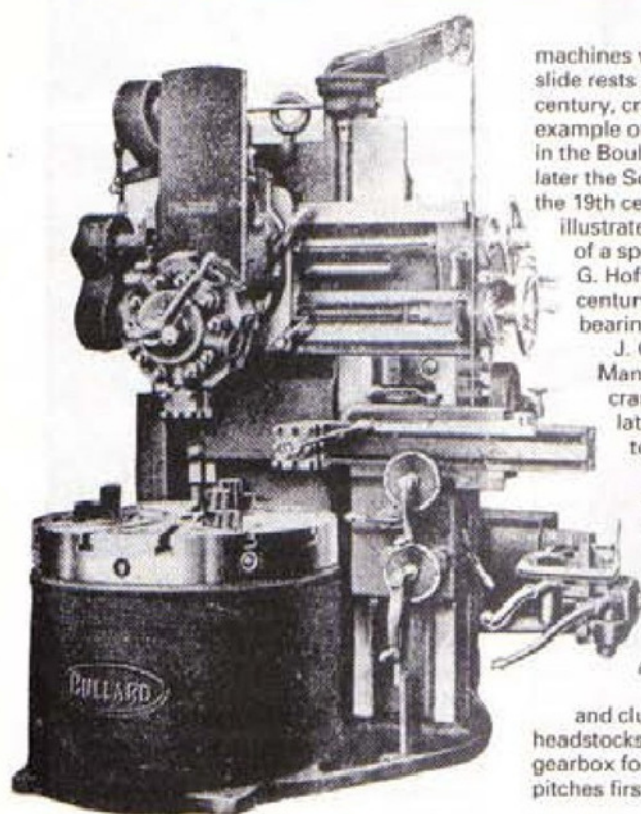


Fig. 18: A Bullard vertical turret lathe
(From A. Herbert Catalogue, 1917).

Today's lathe

In Britain by the end of the 1830s the lathe had basically reached the form of today, the steam engine, the railways and the steam ship stimulating the development of very large and specialised types such as vertical lathes, Fig. 18, shafting lathes, trepanning lathes, lathes for cylinder, wheel and boiler turning,

machines with two headstocks and several slide rests and, in the second half of the century, crankshaft lathes, Fig. 19. An example of a large faceplate lathe installed in the Boulton & Watt's Soho Manufactory, later the Soho Foundry, sometime early in the 19th century and still in use in 1895 is illustrated in Fig. 20. Another example of a special lathe is that invented by E. G. Hoffmann around the turn of the century for turning precision ball bearings, Fig. 21.

J. G. Bodmer, an ingenious Manchester engineer, made his crankshaft and eccentric turning lathe in 1839 and a relieving lathe to produce taps with relief.

The Pittler 'Universal' lathe appeared in 1893, a very versatile machine with a triangular bed and thread chasing gear. In 1902 J. Parkinson made a long screw cutting lathe with automatic tool feed, withdrawal, return and resetting for each cut.

In lighter lathes sliding gears and clutches appeared in the headstocks and the Norton quick change gearbox for changing feed rates and thread pitches first appeared in 1893.

Electric motor drives

The first electric drive was shown at the Vienna Exhibition in 1873 but as motors were very large and crude it was many years before it became generally used. In Britain it was not until the development of smaller electric motors and the general availability of electricity through the National grid in the 1930s that the line shafting and belts began to be replaced by individual motors, in fact many machine shops still had shafting and belts in 1947, as can be seen in Fig. 22. All-gear

headstocks with a single belt drive had appeared by 1900 particularly on capstan and turret lathes.

One useful invention of the 19th century was the 3-jaw self centring chuck. Holtzapffel and Deyerdein made one about 1811, L.E. Gergeron one in 1816 and Maudslay one with 2 jaws in 1820. The first scroll three jaw centring chuck was made by James Dundas of U.K. in 1842 but did not become universal until developed by Cushman of America in 1871.

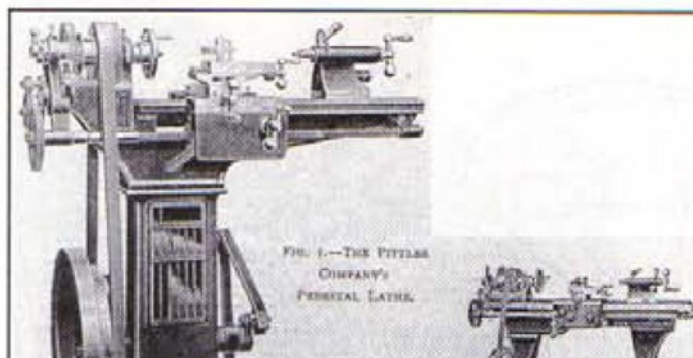
Up to the second half of the 19th century machines were designed for use with carbon steel tools and cutting speeds of 40 feet per minute. This was dramatically changed in 1865 by the discovery by Robert Forester Mushet working at Coleford in the Forest of Dean of an improved self-hardening tungsten tool steel allowing an increase in cutting speeds to 70ft. per minute. In 1900 other workers added chromium and vanadium which ultimately become high speed steel. The effect of this was to enable cutting speeds to be further increased to 100ft. per min. with much heavier cuts. Arising from this machine had to be greatly increased in rigidity and drive power, closer speed ratios and much improved lubrication particularly in the headstock.

Cutting fluids

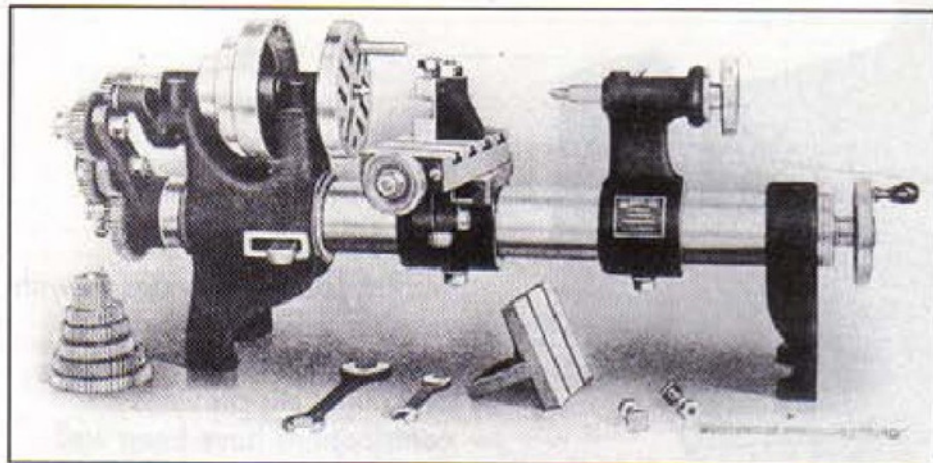
Cutting fluids, water at first, were used as long ago as 1820 by Maudslay but 'suds', water saturated with carbonate of soda, were not mentioned until the 1860s. In an unlikely reference the Rev. Francis Kilvert, curate of Clyro, in *Kilverts Diary* mentions seeing it being used at a Birkenhead shipyard in 1872.

The great advance of the 20th century was Krupps tungsten carbide tipped tool of 1926 with its greatly increased cutting speeds of the order of 400 feet per minute

the round belt, **Fig. 26**. Their two new 'A' and 'B' models of 1902 **Fig. 27**, were however of quite advanced design with flat belt drive but unusually only two steps on the cone pulley as did the slightly later but much cheaper and inferior Relmac and Super Relm lathes, **Fig. 28**.



◀ **Fig. 27:** *The Pittler model "A" lathe. (Model Engineer 1-9-1902).*



◀ Fig. 30: The Drummond round bed lathe. (Model Engineer 21-5-1908).

have eroded its supremacy.

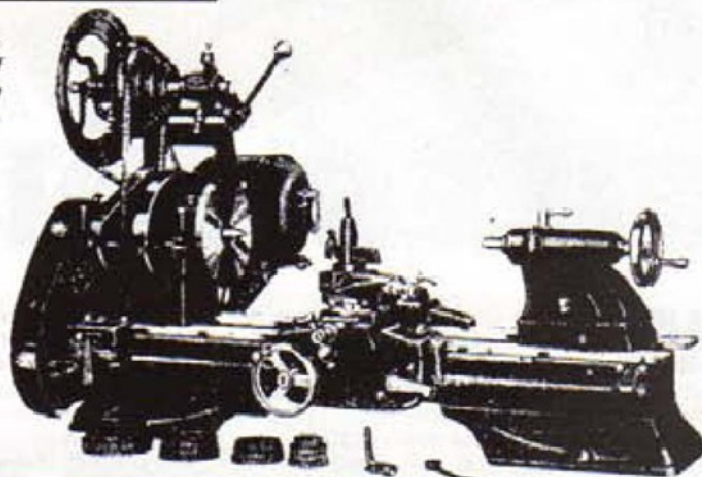
However it is still a very necessary machine in the tool room and jobbing shop and of course for the model engineer!

However by now you have probably finished your long cut and must stop day dreaming.



driven or if power driven by a belt from an overhead countershaft with fast and loose pulleys. One of the first small lathes to be designed for direct drive from a fractional horse power electric motor built in and taking advantage of the greater power transmission capability at close pulley centre distances of the vee belt, was the American 'Atlas' 10in. swing lathe, or 5in. centre to use the British definition, introduced about 1934, Fig. 33, followed shortly after by the 6in. swing and the forerunner of the successful British Myford

Fig. 33: The Atlas ▶ 10 in. swing lathe of about 1934. (From the Tyzack catalogue).

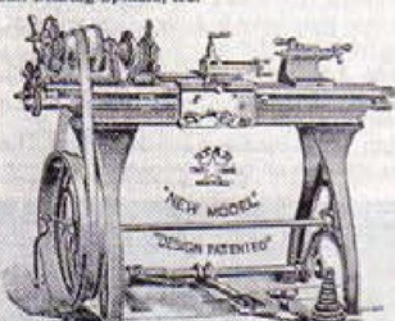


◀ Fig. 31: The Drummond stand at the 1907 M.E. Exhibition. (Model Engineer 7-11-1907).

"STAR" FOOT AND POWER LATHES

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▲ Fig. 32: An American Star lathe. (Model Engineer 15-5-1902).

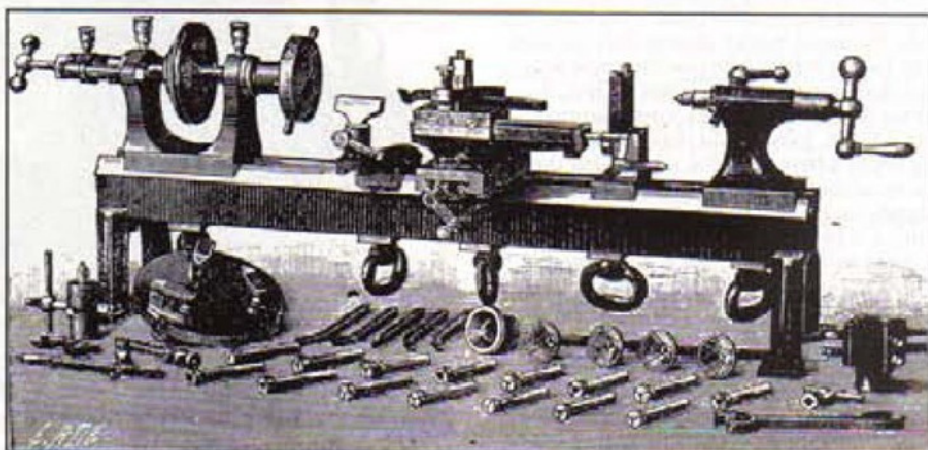
ML7 which appeared about 1946, using a similar drive layout. Many lathe users deplored the loss of the earlier long drive belts on the headstocks and with it the ability to pull the spindle round by hand.

Small industrial precision lathes, particularly for the scientific instrument trade, were largely developed in Germany from 1860 onwards, often not screw cutting, Fig. 34. Some made by Lorch of Germany can be seen on the left of Fig. 7.

The centre lathe was the king of machine tools until comparatively recently when for mass production purposes new manufacturing techniques such as pressure die and lost wax casting, spark erosion, electronic control, NC machining centre etc.



Fig. 34: The Lorch precision instrument makers lathe. (Britten, 1884). ▼



1



The cast iron block in the rough.

Mr R.J. Loader provides us with another article on workshop techniques, this time on files and filing. His previous contributions have been well received as no doubt will this one also.

FILES AND FILING

When I think about starting a project, the main consideration is whether I can make it with the equipment I have. In other words, can it be done with files and a hacksaw where the normal process would be milling. I shall eventually make some sort of milling device, I have all the pieces but lack the time.

Meanwhile, I'm making a raising block for my Unimat and doing the job by hand methods. As **photograph 1** shows, I haven't got too far yet but I'm well on with the worst bit, cutting out the vee to fit the Unimat bed.

Starting with a rough-sawn lump of cast iron and a variety of files, reminded me of my apprentice days. It was policy to 'boil 'em down' at the first year stage with plenty of hand work, especially filing.

One of the first jobs we had to do was to file a 1in. cube to an accuracy of ± 0.002 in. all over. Various metals and plastics were chosen for us, mine was a fairly soft aluminium alloy. I soon learned that softer metals aren't always the easiest to file and that 'pinning' had other meanings than holding fabrics together: more about that later.

Making an accurate cube is an ideal introduction to using files, we didn't think so at the time, but eventually I came to appreciate what useful cutters they are. I've used the word 'cutter' deliberately because that's what they are, in just the same way as a hacksaw blade is a cutter. In fact, if about 20 hacksaw blades were clamped into a block, they would make a file. There are small differences, the rake is less than a hacksaw tooth, it can be zero or even slightly negative, but it cuts with a chisel cutting action. So the first important thing to emphasise is that a file is a cutting tool, not an abrasive stick. The swarf from filing will be a little different from machining swarf, if looked at under a microscope it looks like lumps of grey coal, no tidy curls of metal here, showing how the teeth rip the material off. So even the finest filed finish will be a series of scratches.

Files have been around a long time.

Bronze ones were used in Egypt in about 1500 BC and round and flat shapes were known in Europe in 400 BC. The Romans had combination files which were used to sharpen saw teeth and correct the set of the teeth by a notch at the handle end.

Modern files are made as they have been made for years and the methods and machinery haven't changed much, which is a tribute to the original designs. If it could have been done better, it would have been changed long since. They are made from steel at the high end of the carbon tool steel range with more than 1% carbon, which hardens very hard indeed. There is a penalty to pay for the hardness and files are very brittle because the two things go together. It can be a problem with small and thin ones and I once broke a quite large one

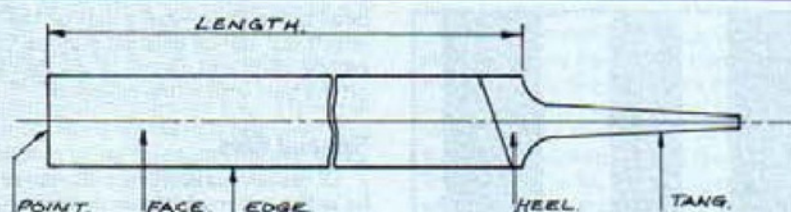
by dropping it on a concrete floor.

A file starts off as a forged blank and the teeth are cut by machine, with the main cut at 70 deg. if the file is single cut, crossed by another set of teeth at 45 deg., if it is double cut, see the sketch in **fig. 2**. Most files are double cut and the 45 deg. one is often shallower than the 70 degree. After cutting they are straightened, hardened and inspected. If they are used for what they are made for, and not as crow-bars, hammers, tyre levers and the various other misuses they have to suffer, they will last a long time and give excellent service.

Fig. 1 shows a standard file, what the parts are called and some of the most common shapes. They are classified by length, cross-sectional shape and cut. The only term which isn't obvious is 'cut', and it



The grip for fairly heavy filing.



THE PARTS OF A FILE

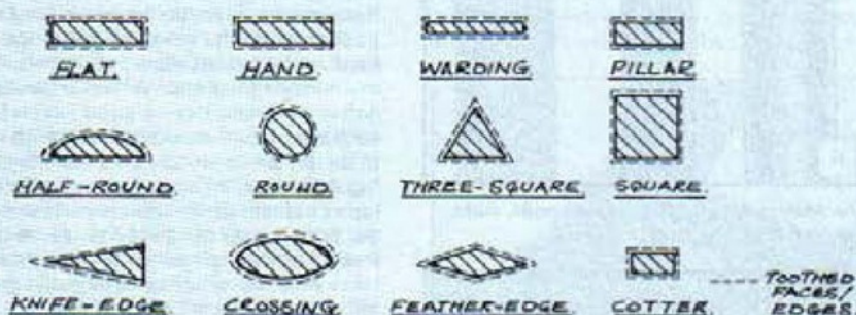


FIG. 1 CROSS-SECTIONS OF SOME COMMONLY USED FILES.

means the tooth spacing in teeth per inch or the metric equivalent. Rough or fine is an easier way of putting it. In order the cuts are: dead smooth, smooth, second cut, bastard and rough. Dead smooth and rough aren't used very much. Dead smooth is a notorious one for clogging and pinning and rough wouldn't move material much quicker than a correctly used bastard. The size of the file has a bearing on the pitch of the teeth as the larger sizes will have bigger teeth. For instance a 4in. smooth file will have 60 teeth/in., a 12in. smooth 40 teeth/in. A 4in. bastard will have 40 teeth/in., while a 12in. will have 12 teeth/inch. Rasps are a different thing, having separate teeth and few engineering applications.

A feature impossible to show on the drawing is that hand, pillar, flat and some other shapes have a 'belly', that is, they are thicker in the middle than at the point and heel. It isn't a large variation; on a 6in. hand file it can be 0.030in. but there doesn't seem to be a definite standard because I have files with pronounced curves and some with hardly any. The reason for the curve is to counter the natural tendency of the user to rock the file, it can be seen quite clearly by sighting along the length of the file. If you are lucky and have one which has slipped through the inspection you may find it is a bit bent. It will never be very much but there will be one side which will be quite convex and make life a lot easier when it is important to make a flat surface.

Sizes range from 4in. to 20in., the largest used is normally 12in or 14 inch. Even the heaviest work I do rarely needs larger than 10in. and my favourites are from 4in. to 8in., although the cast iron lump which started the train of thought needed 12in. ones for roughing out; anything larger is very hard work.

Using files

Shapes, sizes and cuts are one thing, using the files quite another and like all hand skills, the key is sound technique and bags of practice. How the file is held is important and the two photographs of the



The grip for light filing.

block being worked on show two variations of the right way. **Photograph 2** shows the grip for heavy filing where the front hand is gripping the point end firmly, and **photograph 3** where the file is smaller and being used in a more delicate way, shows the front hand supporting and just keeping the file level with no pressure applied. In each case the master hand holds the handle, with the thumb on the top and the fingers curled underneath. The action is a straight push forwards.

To get the action right, the vice must be at the right height as shown in **Fig. 2**. It isn't impossible to file if the vice is above or below this height, but it makes things more difficult than they should be. I do a lot of my filing sitting down at my bench, but my bench is a Workmate and the vice is at elbow height when I am sitting at it. I have found it just as easy to sit down to file as

QUICK TIP

Parallel and taper punches can easily be made from large scrap bolts, such as automotive cylinder head or main and big end bearing cap bolts. Some car manufacturers use bolts that have to be replaced each time they are removed, so they are in abundance. The primary reason for using these instead of silver steel is cost, although not as good, being high tensile they are still strong enough for most jobs.

I used bolts 12mm thread 10.8mm shank 19mm AF hex head and 97mm long. The threaded portion is turned to the punch diameter required, then turned round in the chuck and the head faced and reduced to a diameter of about 1mm larger than that of the shank, and the edges chamfered. Finish off by oil blacking them. **Jason Langan**

stand up.

The other thing the filer needs to do when learning to file is to imagine that he or she is a robot, with pivots at shoulder and elbow, and hand and wrist moving in a slide, straight forward and back. It sounds moronic, but is a good way to learn the action. If practiced enough it becomes automatic and when the filer is truly acting like a robot, it frees the mind to think beautiful thoughts, or in my case to listen to tapes of Puccini's operas or jazz collections. So I never mind a moderate amount of filing. Don't, however, carry the robotic business too far. Pointing a file at one's nearest and dearest and doing a Dalek-like 'Ex-ter-min-ate' is out: it could be the last unsolicited cup of tea you'd get.

Practice and still more practice is the way to get the technique right, then everything is that bit easier.

Ways and means

There are some generalisations which are useful to know.

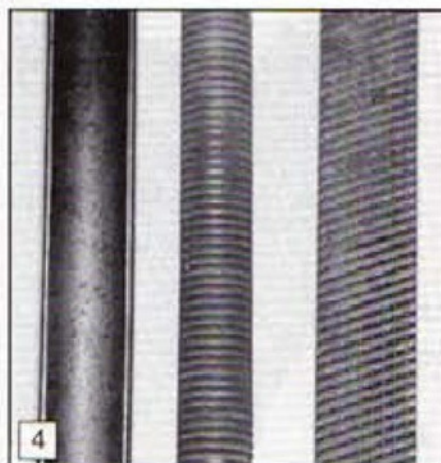
Soft and thick materials cut better with coarse toothed files; harder and thin ones with fine teeth.

Keep new files for the 'skiddy' materials like cast iron, machining brass, cast bronze and some synthetics. When they have been used a bit and won't grab hold of the skiddy metals, they will be right for steels, copper and most wrought metals. The sharpness of a file can be felt by gently rubbing the fingers from point to heel.

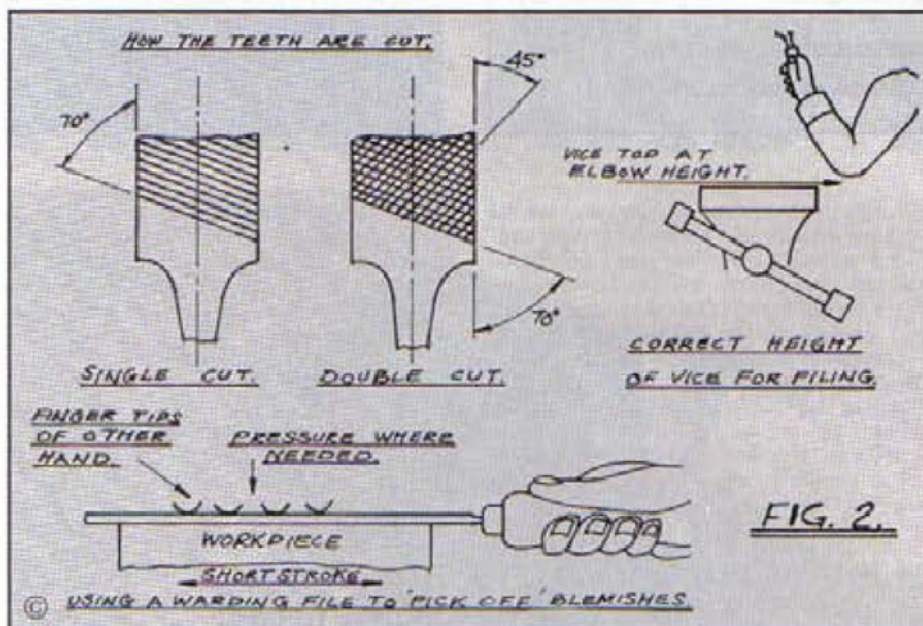
Use the largest file possible, it saves time.

Don't file off large amounts if it can be done with a hacksaw. Hacksaws are very efficient roughing tools.

Hacksaws are good slotting tools. Put two, three or more blades in the frame at



The Millenicut and the curved ones, note the chip-breaker teeth.



once, until the thickness is almost right; cut to depth, then all it needs is cleaning up with a warding or other suitable file.

The shape for the job

Different shapes of file have their own particular use and most explain themselves, like square, round, three-square and half-round; the shape dictates the use. The general purpose types are flat and hand. In one or two lengths and cuts they will do most of the flat surface roughing and finishing. There are some interesting variations.

A warding file is similar to a flat but thinner. It is called warding because it was a shape used to cut the wards in keys, among other things. I use them for slotting and getting into thin gaps where other ones won't go. They will take out blemishes on large surfaces because they can be made to flex very slightly under pressure and by using a short stroke and pressing where the blemish is, as shown in Fig. 2; they will pick it off. It has to be done carefully, warding files break very easily, especially in the smaller sizes.

Pillar and cotter files are the same general shape as hand but much narrower and useful where a hand file is too wide for the gap or slot. One of the most useful features of the hand, pillar and some cotter

files is the safe edge, which is one edge having no teeth and, in theory, quite flat. It is a great help when filing internal steps and corners. Unfortunately, some safe edges are less safe than others because the teeth have been cut after the safe edge has

been made. This leave a burr on the corners which will mark a finished surface. Check before using and if there is any doubt, stone off the burr with a fine oil-stone.

Special files

Of the less usual files, the one I would not be without is my Millenicut. 'Millenicut' is a trade name for a file with very deep, coarsely pitched teeth and two safe edges. Mine has 10 teeth/in. and is single cut. Because the deep teeth make it hard to push through the work, it has groups of teeth with chip-breakers at intervals. It is my heavy shifter and will romp through the softer materials, does a good job on larger sections of mild steel and deals with most of the primitive woodwork I do. It has one big drawback; if I don't remember to wrap tape or similar protection round the point, my fingers get cut where they press on the teeth. I often don't notice until everything takes on a reddish tinge. Ironically, the Millenicut is termed a 'blunt' file, a technical term which means that the cross-section is the same from point to heel, no taper, no belly. My finger ends will witness that the description 'blunt' has nothing to do with the sharpness. Photograph 4 shows the Millenicut and a radius shaped one, the third one is the back view of a radius one; they are made hollow, to save material I expect.

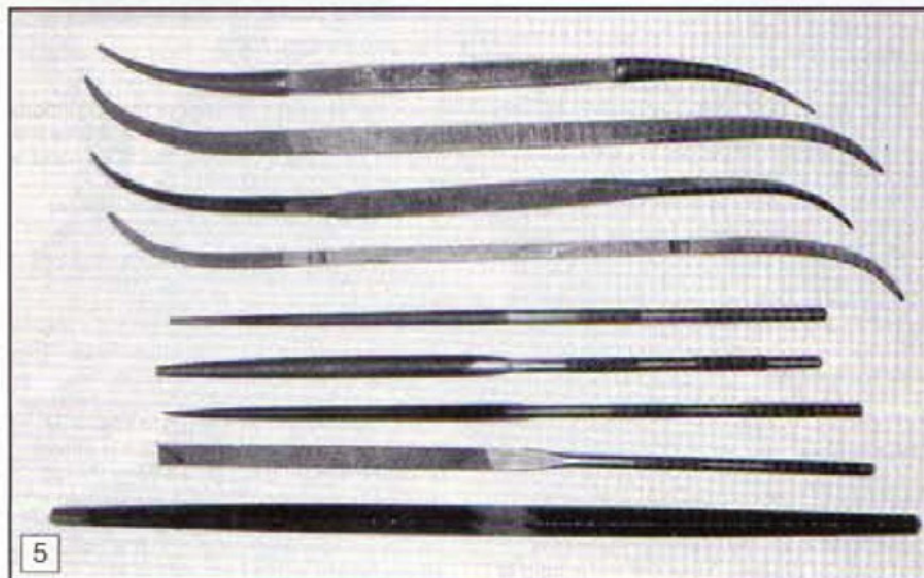
Another favourite is a double-ended saw file. It is three-square, the sides 1/4 in. wide and the length 8 inch. There is a plain segment in the middle and the cut is about the same as a 6 in. hand file. It is ideal for getting into awkward corners and angles bigger than 60 degrees, as one of the photographs shows. It is also a smashing de-burring file, the cut is about like a 6 in. smooth.

Of the other specials, I use rifflers and Swiss files occasionally.

Rifflers are used by tool and die makers to get into awkward places, especially bends and radii. It is a type which won't be used very often in model engineering, but is useful to have in case it is needed.

Photograph 5 shows a selection of rifflers and Swiss files and right on the end, my favourite saw file.

Swiss files are so called because of their use in the Swiss watch and clock industry. I



A selection of rifflers, Swiss files and the double ended saw file.

use these when there is no other which will do the job. They are extremely easy to break and I have lots of short Swiss files. When I worked as an instrument maker I used them a lot for intricate and very small work, but these days there is normally little advantage in using them and I prefer a 4in. one; they are stronger and move the material quicker.

A special file for restoring threads is used in the motor repair trade. It is square in section, doubled ended and has thread profiles cut into it on each of 8 surfaces, giving 8 pitches. It is normally used on a lathe, where a damaged bolt or stud can be dressed in the same way that a chaser works.

For cutting round corners and cutting out the peculiar shapes which are not easy with normal equipment, it is a good thing to have some tension files in the tool box. They are held in a hacksaw frame either by clips which locate a knob on each end, or by a small lug with a hole in, which is crimped to the tension file and fits over the pins which hold the hacksaw blades. They are about 1/2in. diameter and, being round, will cut in any direction. The name tension file means that it needs a tension to cut. If the tension is too much it will pull off the knobs or crimped lugs, so it should be reasonable.

They need using carefully and where a hacksaw blade will put up with being used like a scrubbing brush, tension files won't. When they get too hot, they break. They are invaluable for jobs like cutting blind slots. Holes are drilled at each end, the tension file threaded through and the hacksaw frame assembled round it. You need three hands to do this, but the tension file will cut the waste away very cleanly. There are three grades of cut and they are colour coded, red is the roughest, yellow next and green the finest.

Keep them clean

Whichever shape, size or cut of file is used, it will cut better if it is kept clean. The best file cleaner is a file card and it is used to brush out the swarf which collects and clogs the teeth. The 70 degree cut is the one to brush across because it is the deepest. Soft metals clog the file quickly and often form 'pins', which is a small solid

piece of metal wedged in the teeth. The pin will score a groove across a finished surface, a very frustrating thing, the very thought takes me right back to that 1in. aluminium alloy cube which I laboured so long and hard on as a first year apprentice. So clean frequently with a file card. They are made from carding cloth used in the wood trade for teasing out the fibres. When it is no longer teasing as it should, it is passed on to engineers to use for making file cleaners, which is done by glueing or pinning to a wooden block. When pins are stubborn and won't shift, they can be



Cutting a series of grooves with the corner of a hand file to break the surface up.

moved by rubbing a piece of mild steel or brass along the teeth. If a file card isn't to hand, any stiff wire brush is better than nothing. There is a folk lore that chalk will prevent pinning, but I have never found it very effective; all it does in my view, is artificially reduce the depth of the teeth and make a mess. I also don't use oil on files for similar reasons.

Some more things which aren't in the books

It may sound a silly sub-heading, but it means exactly that.

For moving metal quickly, the file can be angled so that the corner is doing the cutting. It is always easier to cut with a corner than the full face. The corner of a flat or hand file is also useful for those

annoying times when the amount to come off is just too small to be sawn and enough to be hard work. If a series of grooves are cut with the corner, diagonally across the surface, just stopping short of the marked line, crossed with another set at right angles, it will break up the surface so that it is much easier to file down. By the time the ridges have gone, there will be just a clean up to do. **Photographs 6 and 7** show the first set being cut and the finished diagonal grooving. If it is done neatly it will be much admired by wives who will like the pattern.

The corner of a three-square or half-round file is also good for marking and cutting a guide for starting a hacksaw cut. It saves wear and tear on thumbs.



The surface grooved ready to file down.

Filing external radii is easier if a series of flats are filed first to just touch the marked line. The curve can then be blended and finished by draw filing or by following the radius round as shown in **Fig. 3**.

An internal radius is easy if the right size of round or half-round file is to hand. It usually isn't, so a good substitute is a smaller half-round or the corners of a three-square, also shown in **Fig. 3**. The photograph too, shows a half-round being used on a radius considerably larger than the file profile.

When using a round or half-round file, rotate it as it is used, it will give a better finish and wear the teeth more evenly.

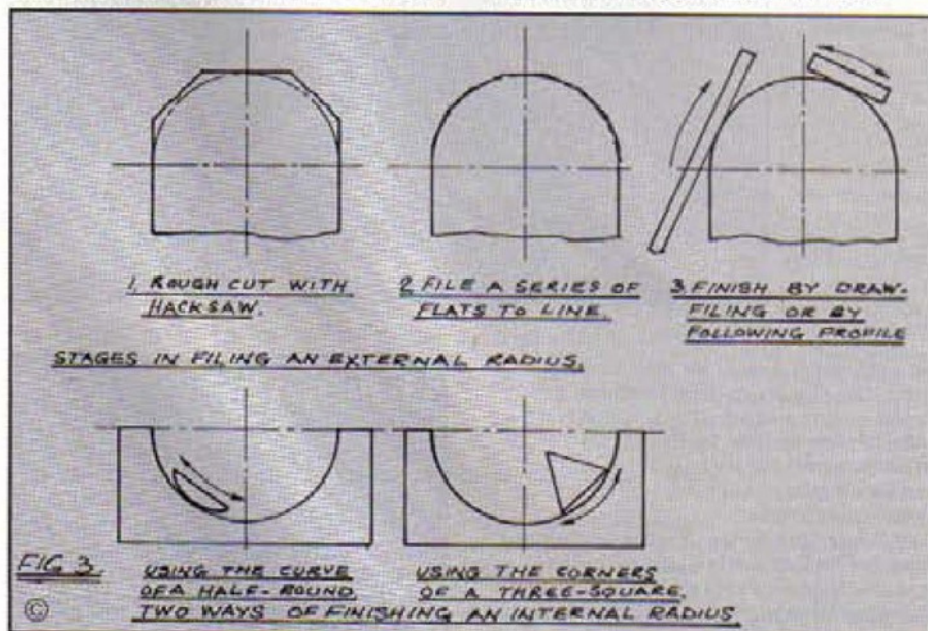
When filing flat, keep changing the direction. A few strokes across the work, then diagonally, then diagonally the other way, then straight again. This does two things; firstly, it tends to average out errors in flatness and secondly, each cut, or set of cuts, is crossing the grooves from the previous set, which helps to break up the surface.

When a surface has to be flat and square to very accurate limits, clamp an accurate and square piece to it, lined up with the line to be filed to. DO NOT use hardened steel, a piece of mild steel stock or un-hardened gauge plate will be accurate enough. If hard material is used it will blunt the file teeth.

When filing very thin material or material which tends to split and break out, sandwich it between two thicker pieces of scrap and have the minimum sticking out of the vice.

If a radius or other feature must be filed to blend with a face and there is a risk of marking a finished face, file against a piece of thin shim between the file and the face to be protected. It will shield the surface and if the shim is thin enough, the file will almost get down flush.

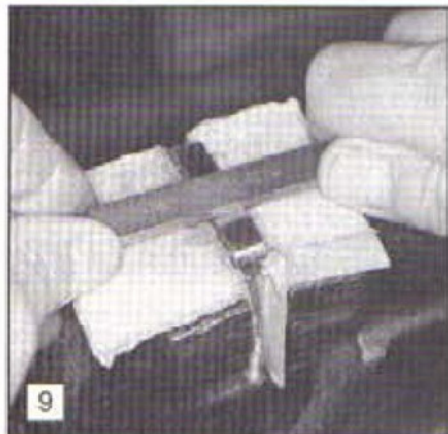
Draw filing (moving the file with a side



to side motion) is not only an acceptable method of combining reasonable finish with flatness, but it also keeps all the filing lines in the same direction. It will only give as fine a finish as the pitch of the teeth, because when a file is cut, the cutting raises small chisel points where the teeth cross and it is the spacing of these points which governs the finish. Draw filing therefore, needs a fine file. It is also a way of cleaning up a surface which isn't quite flat, because the file can be angled slightly to get rid of marks and scratches;



Filing an internal radius with a half-round file, note the thick card used to stop the vice jaws marking the work.



Draw filing the pivoting link. The file is slightly angled to get rid of a blemish.

photograph 9 which is of the pivoting link being finished by draw filing shows this. Note that the file used is a very fine one and the top face of it is due to be cleaned.

Don't be tempted to centre punch round the profiles of shapes to be filed, the half punch marks left will look unsightly or you will have to file large chamfers to get rid of them. It was an archaic method of solving disputes between markers and fitters dating from the time when men were employed to mark out the work for the fitters to complete. Disputes were avoided by the centre punching of the lines; if the finished work showed half a centre punch mark everyone was satisfied.

Safety

Most safety precautions when filing are common sense but the one essential is to have a handle fitted. There are only a few sorts of file which don't need a handle; Swiss files have an integral one and double-ended ones like rifflers and saw

files have a plain section in the middle. All the others with pointed tangs **must never be used without handles.**

If isn't enough to just bang the handle on the file, they should be burned in. This is done by drilling a stepped hole with successively larger drills $\frac{1}{16}$ in. less deep than the tang length, the smallest drill a little larger than the thickness of the end of the tang and the largest a little smaller than the width of the tang at the heel of the file. Make sure that all the wood shavings are tapped out of the hole, heat the first $\frac{1}{4}$ to $\frac{1}{2}$ in. of the file tang till it is red-hot and press the handle firmly on and tap gently till it stops. Do it out of doors if you can; it makes a lot of acrid smoke. When the smoke has cleared, the handle should be an excellent fit and will knock off and back on as required. The gap between the ferrule of the handle and the heel of the file should be between $\frac{1}{16}$ in. and $\frac{1}{8}$ in. depending on the size.

Handles are usually ash or similar wood and will have a ferrule which stops them from splitting. Any handle with a split in it should be thrown away.

Storing files is a problem and some of mine have had to take their chances. I have got a rack which holds about a dozen, but I use far more than that. I have an idea for making a storage block for them, like a knife block which cooking enthusiasts use to hold the different knives. It shouldn't be too difficult and would tidy up my working space a lot because a lot of the clutter is files; I shall give it some thought.

Re-cycling

I know that this is one of the modern buzz words but it does apply to files, the ones made from the traditional carbon tool steel that is. They will be still useful when worn out, that takes a long time to do but when they won't cut any longer, they can

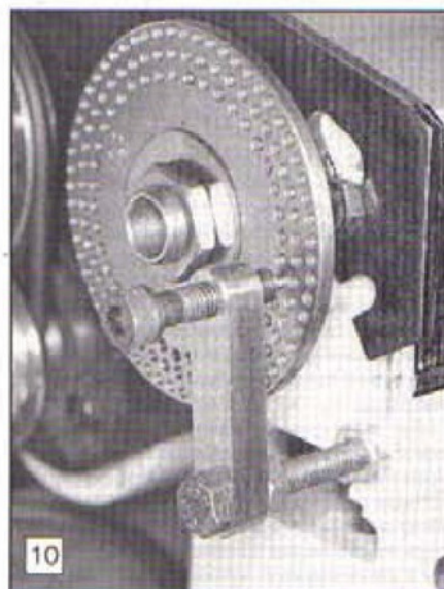
How not to put a handle on a file, this would be suitable for one several sizes smaller.



be softened and used for making other tools. Old files make ideal scrapers, good wood chisels and form tools which can be used at slow speeds. I always have a stock of softened files of various shapes and sizes so that I can cut lumps off as and when I need them.

It is not a good idea to make cold chisels from old files; it needs a slightly tougher material to put up with the shock from being hammered.

There are other spin-offs from filing.



The finished pivoting link, a part of the Author's primitive indexing device.

When young, it will develop the grip and hand muscles; when older, it will find out the hand joints which are subject to arthritis and similar troubles. On the gardening side of things, the raising block I'm making has produced vast amounts of cast iron swarf and dust. Now, I've been told that iron dust is very good for turning the flowers of hydrangea from the natural pink colour to blue. I have deposited quantities of the dust round the roots of our hydrangea: unfortunately it has chosen this year to be very poor and looks quite dodgy. I await results, so far the few miserable florets are stubbornly pink. I don't think there will be any blue ones, not even a rust coloured one; perhaps I've killed the poor thing.

QUICK TIP

A selection of polishing sticks for the polishing of bores in the lathe can be easily made by gluing charmois leather pieces onto the ends of wooden sticks to resemble drum sticks. The leather is then charged with abrasive polish of different grades.

Alan Jeeves

The M.E. Unique file comes complete with plastic handle.

Readers may be interested to know that our sister magazine *Model Engineer* originated a design for a special file, known as the *M.E. Unique*. This is made as a combined forward cutting (one side) and

backward cutting (the opposite side) file. The idea of the backward cutting, i.e. pull towards the operator to cut is for operation in the lathe, where it can be most useful when one indulges in such forbidden practices. As a bonus the extreme end of the file is left bare of cutting teeth, so that

the end can be formed into a scraper without disturbing the usefulness of the file.

Until now the file was only available to *Model Engineer* readers. In order to complement this article it is being offered to *M.E.W.* readers. Price of this very useful tool is a modest £6.95 including p&p. The order code is ROME/55 and the file is available from Readers Services, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST. Please allow 28 days for delivery.

A Glossary of Swiss File Terminology

AURIFORM FILE A die sinkers' file having a cross section that combines 1/2 of a pippin file with 1/2 of a crossing file.

BACK In a half round, barrette, cant or files of similar cross section, this is the convex side.

BARRETTE FILE Cut on wide flat face and safe on sides and back. Tapered in width and thickness.

BENCH FILING MACHINE FILE Parallel files of various cross sections for use in filing machines.

BLANK A steel forging from which a file is made. The basic shape of a file before teeth are cut or etched.

CANT FILE Triangular in cross section with one side wider than the other two. Cut on three sides tapered.

CHECKERING FILE Rectangular in cross section and parallel in width and thickness. Teeth cut at 90° angle with edge. Safe on edges.

CHISEL CUT A method of cutting teeth into the surface of an annealed file blank by striking it with a series of repeated blows as the blank is moved beneath a chisel at a uniform speed. In the cutting operation, the chisel is placed obliquely to the length and is inclined to the surface of the file. This is done either by hand or machine. Generally used to produce files of No. 2 cut and coarser.

CROCHET FILE Rectangular in cross section with rounded edges. Cut on both faces and edges. Tapered in length and slightly tapered in thickness.

CROSSING FILE Oval cross section with same radius as half round files on one side and other side curved to a larger radius. Cut on both sides. Tapered in width and thickness.

CUT The number of teeth per inch, the degree of coarseness of a file's teeth, from No. 00 to No. 8 in Swiss precision files. Also used to describe the type of file such as single cut or double cut etc.

DIE MAKERS' RIFFLERS Various cross sectional shapes. Teeth cut on a small area of each end leaving a long middle portion as a handle. The cut ends are of various designs. Length is overall. Originally designed and hand forged by die makers for their specific purposes, now a generic term for this particular group of rippers.

DIE SINKERS' FILES A group of files of various cross sections designed for use by die sinkers and tool makers. Tapered in width and thickness.

DIE SINKERS' RIFFLERS See Die Makers' Riffilers. This group of rippers has smaller cross sectional shapes.

DOUBLE CUT The arrangement of file teeth formed by two series of cuts. The first is the overcut which is followed by the upcut at an angle to the overcut.

EDGE The narrow cross section or side of a file.

EQUALLING FILE Thin rectangular cross section, parallel in width and thickness and cut on both faces and edges.

ESCAPEMENT FILE Also called Square Handled Needle Files. A group of files of various cross sectioned shapes with a length of cut varying from 3/4 to 2-1/2" and long square handles. Widely used by jewelers, watch makers, die makers, and fine mechanics.

ETCHED CUT A method of cutting teeth into the surface of a file blank by drawing an etching tool, under sustained pressure, obliquely across an annealed file blank in a series of cuts. This may be done either by hand or machine. This method of cutting is used where it is necessary to retain the true cross section to a file. Generally used to manufacture files finer than a No. 2 cut.

FACE The working surface of a file upon which teeth are cut.

FILING BLOCK A block of wood, soft metal or other material used to protect the material being filed from damage from the jaws of a vise or other holding device. It may contain a series of grooves to hold work securely.

FLAT FILE Also called a Warding File. A form of escapement or square handled needle file. Parallel in thickness. Cut on four sides, tapered in width.

HANDLE A wood or plastic piece that is placed over the tang of a file to protect the hand of the user.

HALF ROUND FILE A cross section that is flat on one side and has a radius (not half circle) on the other side. Cut on both sides. Width and thickness taper.

HALF ROUND SLIM FILE Also called Ring File. Same as half round except thinner in width.

HEEL The end of the file at a location where the body ends and the taper leading into the tang begins. Also called the shoulder.

JOINT FILE ROUND EDGE Rectangular cross section with rounded edges. Cut on edges only. Parallel in width and thickness.

JOINT FILE SQUARE EDGE Rectangular cross section. Cut on edges only. Parallel in thickness and width.

KNIFE FILE Knife shaped cross section that is tapered in width and thickness. Edge has same thickness from point to shoulder.

LENGTH OF CUT The length of a file measured between the shoulder or heel and the point.

LOZENGE FILE Diamond shaped cross section parallel in width and thickness.

MACHINE FILE A file made specifically for use in a filing machine. Various cross sectional shapes. Parallel in width and thickness.

NEEDLE FILE SQUARE HANDLED Also called an escapement file. A group of files of various cross sectional shapes with a length of cut varying between 3/4" and 2-1/2" and long square handle.

NEEDLE FILE ROUND HANDLED A group of files of various cross sections with a knurled round handle. Knurling gives the file a positive, non-slip grip for precision filing.

OVAL FILE An oval cross section tapering in width and thickness.

OVERCUT The first of a series of cuts in a double cut file. Its function is to act as a chip breaker. The second or upcut is made over this cut.

PARALLEL MACHINE FILE A group of parallel files of varying cross sectional shapes made specifically for use in reciprocating filing machines.

PARALLEL ROUND FILE A round cross section parallel in width.

PARALLEL SQUARE FILE A square cross section parallel and thickness.

PILLAR FILE A rectangular cross section with thickness greater relative to width, than in other types. Cut on face or flat sides only. Parallel in width, tapered in thickness. Also demi-narrow, narrow and extra narrow widths.

PIN OR PINNING The tendency of small particles of materials to fill or clog the gullets between the teeth of a file. When the teeth become clogged the file causes scratches on the work. When this occurs the file is pinned.

PIPPIN FILE A section that combines the cross section of a round file with that of an equalizing file. Tapered in thickness and width.

POINT The front end of a file as contrasted with the tang end.

POINTED BACK BARRETTE FILE A triangular cross section with one side wider than the other two sides cut on wide or face side only tapered in width and length.

RASP CUT A cut used on wood rippers that is made by a punch raising a series of individual cutting teeth.

RIFFLERS From the German riefeln, to channel, chafer, flute or groove. Originally used and hand forged by die sinkers, die makers, silversmiths and other skilled artisans in shapes and cross sections appropriate to their work. Teeth are cut on small areas on each end that can be shaped like everything from frowls to button hooks. A long middle portion serves as a handle.

RING FILE Also called a half round slim file.

ROUND FILE Round in cross section tapered in width.

ROUNDING OFF FILE An escapement or square handled needle file half round in cross section. Cut on flat side. Parallel in width.

SAFE The side or edge of a file that has no teeth cut in it so as not to mar a work surface that does not require filing.

SCREW HEAD FILE A narrow diamond shaped section with short bevels to form sharp edges. Cut on beveled edges, safe on flat sides. Parallel in width and thickness.

SECTION The cross section or end view of a file if it were cut squarely at the place of greatest width and thickness from the tang.

SILVERSMITH'S RIFFLERS A group of various cross sectioned shapes originally designed for use by silversmiths. Teeth are cut on small areas of each end leaving a long middle portion as a handle. The cut ends are of varied designs.

SINGLE CUT The teeth formed on a file by a single series of cuts.

SLITTING FILE A flat diamond shaped cross section. Cut on all sides. Parallel in width and thickness.

SQUARE FILE Square in cross section. Cut on all sides. Tapered.

TANG The part of the file that tapers from the shoulder that is intended to be fitted with a handle.

THREE SQUARE FILES Equilaterally triangular in cross section. Cut on all sides with sharp corners. Tapered.

TOOL MAKERS' RIFFLERS Various cross sectional shapes with teeth cut on a small area at each end leaving a long middle portion as a handle. The cut ends are of various designs to meet the needs of tool makers.

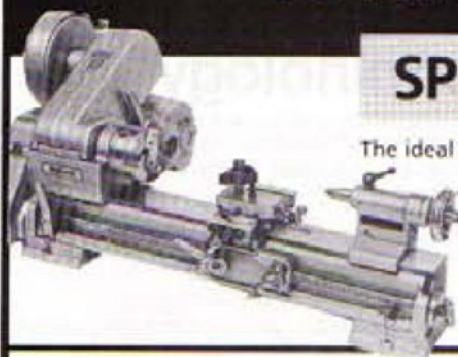
UPCUT The second series of teeth cut in double cut files made over the first series of cuts called the overcut. This cut is made at an angle to the overcut.

WARDING FILE A rectangular cross with teeth cut on all sides up to 4" in length and on 3 sides with one safe edge on files 6" and longer. Tapered in width, parallel in thickness.

We are grateful to *Blundell Files and Tools Ltd. of Prescott, Liverpool* for their permission to include the *Glossary of Swiss File Terminology* from their catalogue. *Blundells* are an old established firm who still produce quality files using the traditional methods, and a highly skilled workforce all of whom are able to take over any process in the manufacture at short notice. An article about the process of making files appeared in *M.E.* 15 May 1992, page 582. Photocopy reprints are available, from the address above.

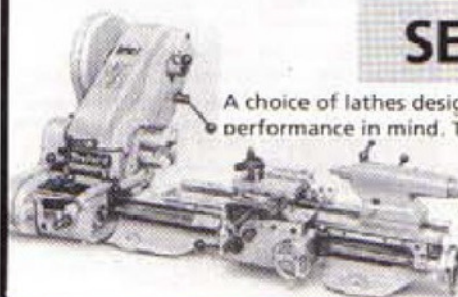
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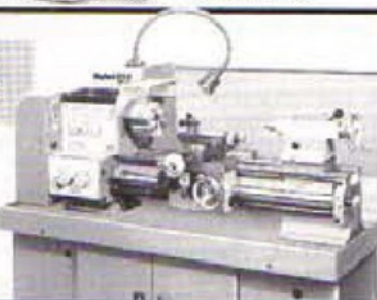


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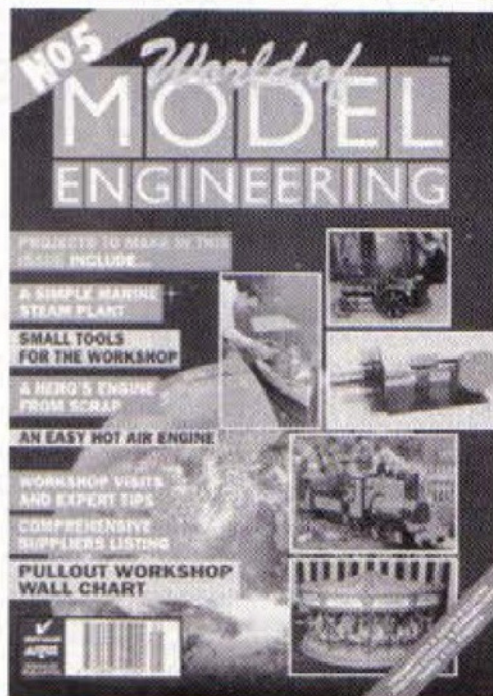
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Welcome to THE WORLD OF MODEL ENGINEERING 5



In this, the fifth in the series, well know model engineer Stan Bray offers a practical mixture of interest and inspiration for home workshop enthusiasts of all levels of expertise.

Stan is one of Model Engineer magazine's most popular contributors and his straightforward, practical advice has launched many a modelling career over the years!

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In short, there's something here for all modellers (including an invaluable pullout workshop wall chart).

Welcome to the wonderful World of Model Engineering!

PUBLISHED ON MARCH 26

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The universal band saw is fast becoming a popular item in the home workshop. This review of the Clarke CBS45MC 4½in. capacity saw, details the advantages of such a machine, and thereby the reason for its growing popularity.

The universal band saw has, over recent years, become a common item of equipment to be seen in the catalogues of most suppliers to the home workshop. Most, if not all, are of East Asian origin and all use the same design principle. They do however have slight differences, showing that they originate from different manufacturers, or perhaps assemblers. The one reviewed in this article, seen in **photograph 1**, carries the well known name of Clarke, being their CBS45MC, and is available from Machine Mart.

The design of these machines follows closely that of the well established industrial horizontal band saws, though being smaller in capacity, similarly in size and price. They are therefore essentially a horizontal band saw, a function that they perform well. In this respect it is worth considering that, compared to the alternative, the motorised hack saw, the cut is continuous and therefore quicker. Of course, this statement is only applicable if machines of similar size are being compared.



1: The Clarke CBS45MC 4½in. universal band saw.

2: The saw in the as supplied condition.

1

THE CLARKE BAND SAW REVIEWED



Their vertical band saw facility is however really a compromise, having a small table added to the machine whilst the saw is raised to the vertical position, in this mode the table is not at an ideal height, being too low. Also, having the base of the saw projecting out at the front, access to the table is somewhat limited.

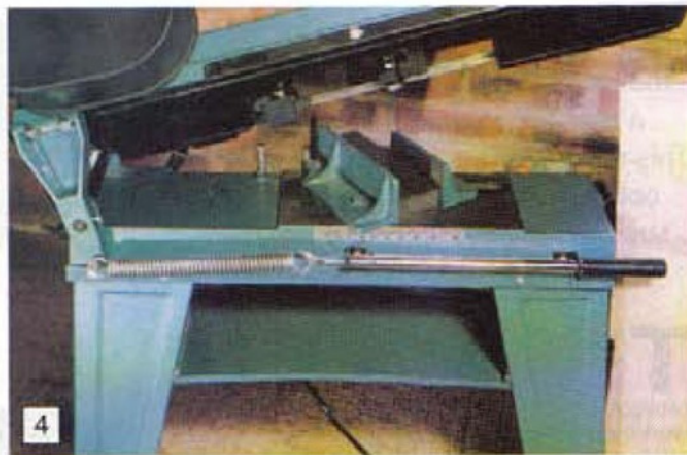
The saw comes well packed in a heavy cardboard box with moulded polystyrene inner. Obviously to save on the size of the package to be transported, some final assembly is left to the purchaser. This mainly consists of the stand and adding the drive belt cover and a few other very minor parts, these can be seen in **photograph 2** which shows how the machine is supplied.

The instruction sheet is written on the basis that the motor will be provided by the purchaser and gives full instructions for fitting this. It is however supplied fitted and there are no instructions for the assembly that has to be done, this is a situation that I feel many will have grown to accept with items from East Asian manufacturers.

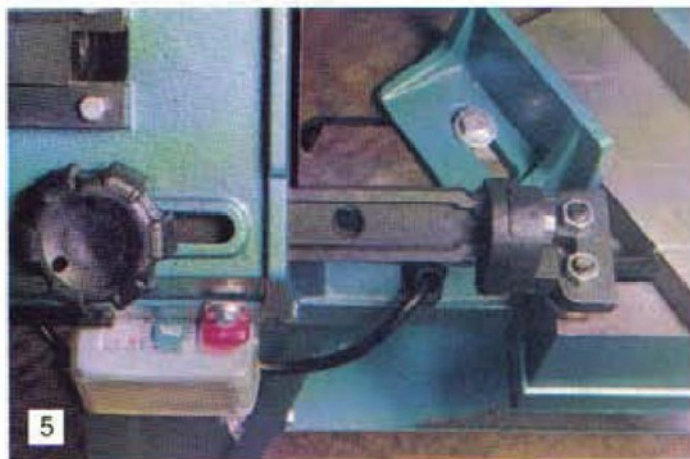
It would only be fair to say regarding the absence of such instructions, that the sheets provided do have a good exploded view of the saw. It is also true, that the assembly work to be carried out requires



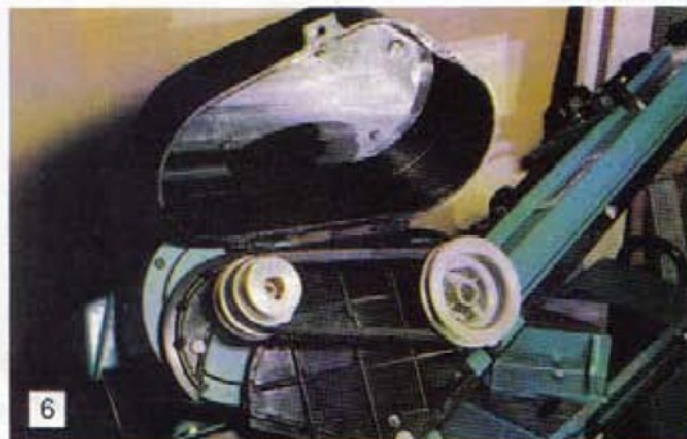
3: The saw in use, note how the guides are adjusted to be close to the item being cut.



4: Rear view showing the counter balance spring with its handle for adjusting its extension. Also seen in the view the markings for setting the angle of the vice, this is not very accurate but should be adequate for most cases



5: Close-up of the adjustable guides, extension is locked by the plastic knob on the left.



6: Speed change belt system with cover.



7: The push button switch. Note the plastic cover over the switch which will prevent the entry of swarf or cutting fluid, also the heavy duty bushes with strain relief where the cable passes through the frame.

only a little thought to enable it to be carried out satisfactorily.

The main assembly comes complete and weighs around 45Kg, the total package, as supplied, weighs some 55Kg. In view of the weight of the main assembly some help assembling this onto the stand is highly desirable, though in my case I did manage it on my own. The remainder of the assembly is very simple. Fit a plug to the mains lead and it is ready to run, or is it?

The instruction sheet provided states that the saw has been factory set and I have no reason to suppose otherwise. The saw that I received had rings around both the bearings that rest on the back of the blade indicating that it had been run. However the saw is only supplied with one blade and it would be very frustrating if after a few test runs some mishap caused the machine to be in need of a new blade.

Setting up a saw is perhaps a little more critical than anticipated, albeit mostly common sense when thought is given to the subject. With the power disconnected it

would be preferable to carry out the following tests. First inspect the pairs of blade guide bearings to ensure that these are positioned such that they do not place any twist along the length of the blade where the cutting action takes place. Follow this by moving the blade using the drive belt and ensure that it is properly supported on the back of the blade by the bearing for this purpose. Now the four bearings which support the sides of the blade, these should rotate freely but with virtually zero clearance.

On the saw being reviewed one bearing out of each pair is mounted on an eccentric spindle for the purposes of adjustment. With this it is possible to turn the spindle until the bearing becomes stiff to turn, then by slowly returning the spindle until it becomes just able to rotate freely. There should be a maximum of 0.001in. clearance. Follow this by switching on and running for a few seconds, stop the machine and inspect to see that the blade is still correctly in position.

With these initial precautions taken, the

saw can be put to use (photograph 3) without fear of any major problems, but see also comments later in this review which relate to setting up the machine for precision cutting. The saw is provided with a 14 TPI blade which is ideal for cutting bright mild steel, a task that it does with ease. The days of much energetic work when cutting off that piece of steel, will be a thing of the past with a saw such as this in the workshop.

The capacity when used as a cut off saw is 4½ x 6in. much more than is likely to be required in the majority of home workshops. It is probable however that, with the saw installed in the workshop, larger projects will be undertaken than would have been without it, it has certainly made me think. It is interesting to note that both the last two readers who have been the subject of workshop visits, have voluntarily extolled the virtue of owning such a machine. The vice can be set at any angle up to 45 degrees, the action of which is to reduce slightly the width of material that can be accommodated.

To be able to adjust the pressure exerted on the item being cut, the weight of the upper section of the saw is counter balanced by the fitting of a very strong spring. At the rear of the machine is a handle which operates onto a screwed eye this being made to alter the extension of the spring and therefore the pressure of the blade on the item being cut, this can be seen in photograph 4. Both pairs of guide rollers can be moved along the length of the blade, thus enabling support to be given as close as is possible to the item being cut, see photograph 5.

The saw is driven by a 0.33Kw electric motor and is provided with three step cone pulleys, **photograph 6**, giving blade speeds of 65, 95 and 165 feet per minute. The belt guard is easy to open using a single screw and belt changing is as a result quite quick. The belt tension screw, fitted with a small plastic knob, is difficult to adjust due to limited space, a normal screw with hexagon head and adjusted with a spanner would be preferable. As mentioned earlier, these machines from differing sources are very similar and those that I have seen all use the same method of adjustment. However the motor fitted to the Clarke machine appears a larger frame size than some, not a bad thing as it will help to ensure the motor runs cooler, and this contributes to the problem of access to the belt tension screw.

Having seen some horrors when it comes to the electrics on machines from East Asia, it was decided to look under the bonnet. Outwardly the cables which run between the incoming supply, the motor switch and the motor itself, are all of a robust nature. They also, for the purpose of protection and tidiness, pass through the machine frame in numerous places. At each place the cable passes through a substantial bush which also incorporates strain relief, see **photograph 7**. They are also clipped to the frame in a number of places. So outwardly full marks. Next the motor was considered, this outwardly looked well made, and inside the terminal box and the capacitor coverall connections were very well done and grommets fitted where appropriate. So all round a far better result than has often been the case, especially on earlier machines.

The two push button switch is covered with a heavy duty transparent flexible cover (**photograph 7**) which will effectively ensure swarf or cutting lubricant will not gain access. The switch is not of the no volt release type which means that if the starter is left on the machine will start up when plugged into the mains and the mains switched on. This is unfortunate but is not unreasonable on the basis that it is highly probable that other similar machines are also equipped in the same manner.

On this basis it would not be suitable for use in either school or industrial premises, the machine is clearly marked to this effect. As would be expected, the saw is arranged to switch off automatically when the cut is complete, this is done by the simple action of a plunger coming down on the stop button as the blade passes through the material being cut.

The saw can be bench mounted and this main portion, comprising an upper and lower casting, is very robust and in all the essential areas appear well made. On the other hand, the add on sheet steel stand is, by comparison, a little on the flimsy side, albeit adequate for the task. The wheels provided for moving the machine only contact the floor when the machine is raised for moving, the machine is therefore carried by the stand in the operating position.

Because of the flimsy nature of the stand and the fact that the wheel assembly itself is also not that robust, moving the machine may not be as satisfactory as one would like. It would however only be fair to state that moving the machine only became unpleasant, but still possible, when being moved on the rough surface of my garage

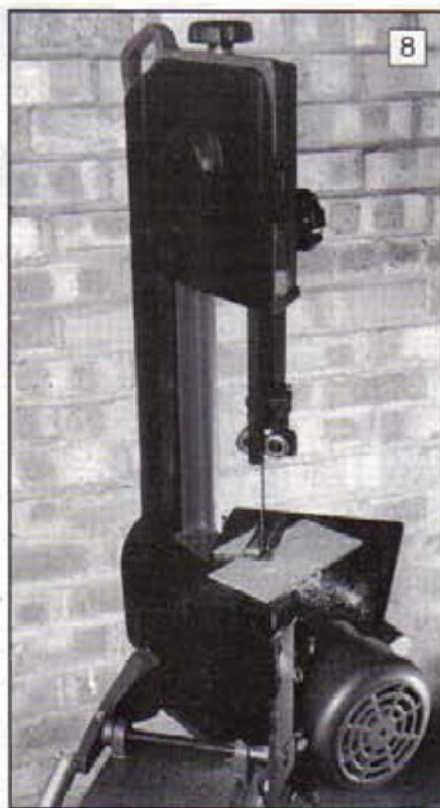
floor, on the smoother floor of my workshop there was no problem. The machine takes up quite a large floor area, and will also require, on many occasions, space to the left and right for the item being cut. Because of this, the provision for moving the machine is a very useful one, as it is probable that it will be stored in one position and used in another.

The general construction is adequate but, as with many machines of East Asian manufacture, it is probable that the user will decide to add a few finishing touches. There are no obvious weaknesses in the machine that will stop it functioning adequately without such improvements.

With regard to operating instructions, these are adequate and include what appears to be a very good trouble shooting chart. The booklet also includes a very good exploded assembly drawing showing all the parts that go to make up the unit. This would be very useful if ever it is required to dismantle the saw in any way, or purchase spares. As was stated earlier the instructions for assembly are not strictly accurate, similarly the details for adjusting the blade tension and guides. Fortunately the principle of what is required is quite plain, and the errors relate to the actual constructional details of the machine which have obviously changed slightly since the instructions were drafted. The errors are therefore not that serious.

However for precise adjustment, required to ensure the saw cut squarely in both directions, that is across and through the material being cut, it would be worth reading the article on these saws published in *Model Engineer*. A *Silk Purse* part two published in *M.E.* 3915 deals with the question of the adjustments required.

The blade size is $\frac{1}{2} \times 0.025 \times 64$ in. and is easily available in a range of TPI. Fitting blades requires the removal of a number of guards, the whole process not being that difficult, probably taking about 5 minutes



8: The saw raised and the table fitted for use as a vertical saw.

Vertical band saw

It was found that using the machine in the vertical mode (**photograph 8**) was, as anticipated, less than ideal. It must be said that for that individual who would only make limited use of the facility, it is a good provision on a machine that is essentially a horizontal saw. Even so, the limited depth of throat would still mean, that for those having a lot of use for this facility, a separate conventional vertical saw would be preferable.

It can therefore be said that considering its limitations being less than ideal operating position, limited throat (3in.) and small table size (10 x 10in.) its capabilities are very good for the occasional use, see **photograph 9**. These limitations are, of course, also applicable to all similar machines of other makes.



9: Being used on a piece of 3mm aluminium, it was also used in this mode on $\frac{1}{16}$ in. thick steel which it cut with relative ease.

Conclusions

As a cut off saw, the universal band saw will eliminate much hard work in preparing blanks for further machining, either on the lathe or on the milling machine, this will be particularly so for those who work with larger size materials. Of greater importance, I feel, will be the ability to take on projects using even larger size materials, which otherwise would have been considered non-starters.

The vertical band saw is a useful additional facility for those without a stand-alone machine and will, in this case, be beneficial in making projects more practical to undertake. If space and money is available, then I feel this type of machine should be given serious consideration as a machine for inclusion in the home workshop.

Dimensions

The overall dimensions are: length 40 $\frac{1}{2}$ in., width 16in., height 36in. (as a cut off saw) 54in. (as a vertical saw).

Details

For further details contact Machine Mart Limited, Dept. M.E.W., 211 Lower Parliament Street, Nottingham NG1 1GN. Tel. 0602 241004 or visit one of their many superstores - see advertisement.

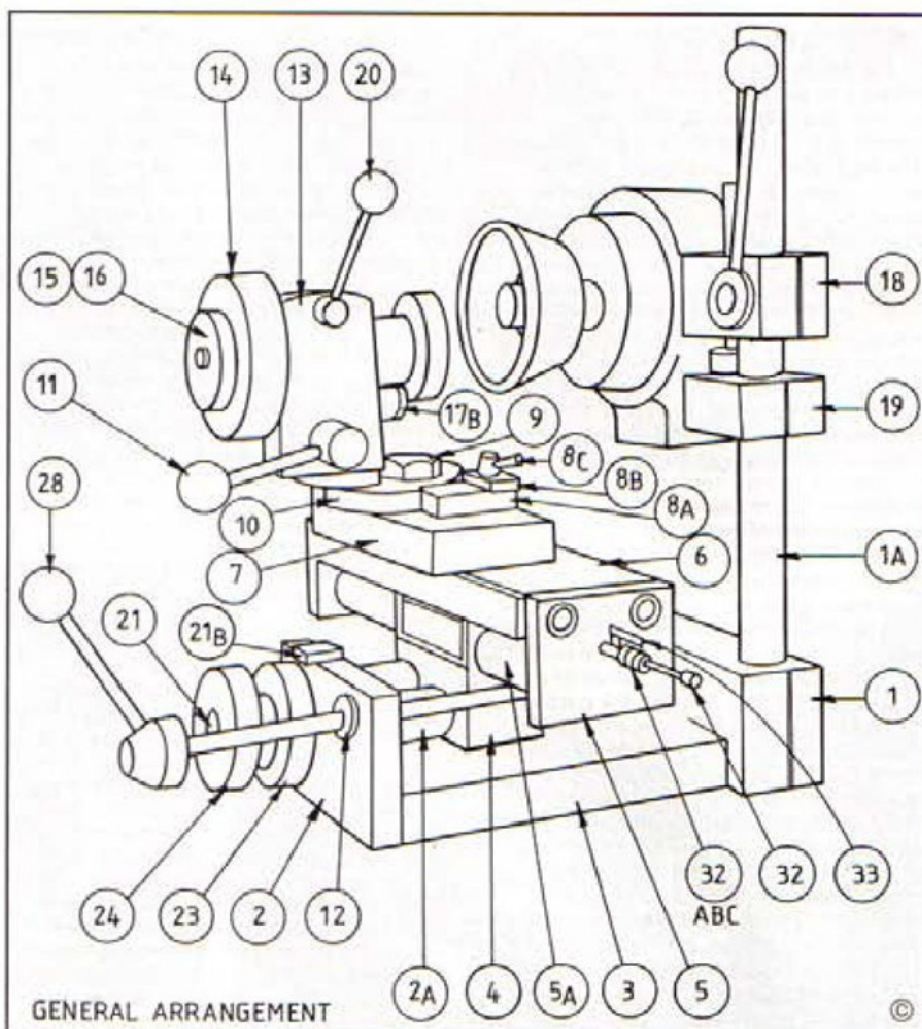
Copies of articles previously published and mentioned above can be obtained - £1.50 for U.K. readers and £2.00 overseas readers. Requests should be sent to the Photostat Service, Argus Specialist Publications, Boundary Way, Hemel Hempstead, Herts. HP2 7ST.

Note the full article *A Silk Purse* was published in four issues of *Model Engineer* Nos. 3913/5/7/9 and counts as four articles. That from 3915 mentioned in the text can be obtained separately if required.

Amongst the top items, if not the top, requested by readers of *M.E.W.* is assistance with tool and cutter grinding. Following the recent article on a simple device for sharpening end mills, we now have in this issue a fully fledged tool and cutter grinder provided for us by Derek Brooks.

The grinder is constructed from stock materials, there being no castings required. The article is published in two parts.

Having a lot of blunt cutters in my boxes which were almost useless, I decided it was time that I had some means of sharpening them. Another bonus is that many firms are now throwing such items away. After checking on the price of commercial grinders and kits I set about making my own. Having no means of surface grinding, I gave my design a flat bed to facilitate this. Dovetailed and flat slotted beds need very accurate milling so I resorted to round bar beds which only need accurate drilling. Everything has had to be made from stock material to avoid the use of castings. Needless to say though all the flat pieces need to be flycut and made square.

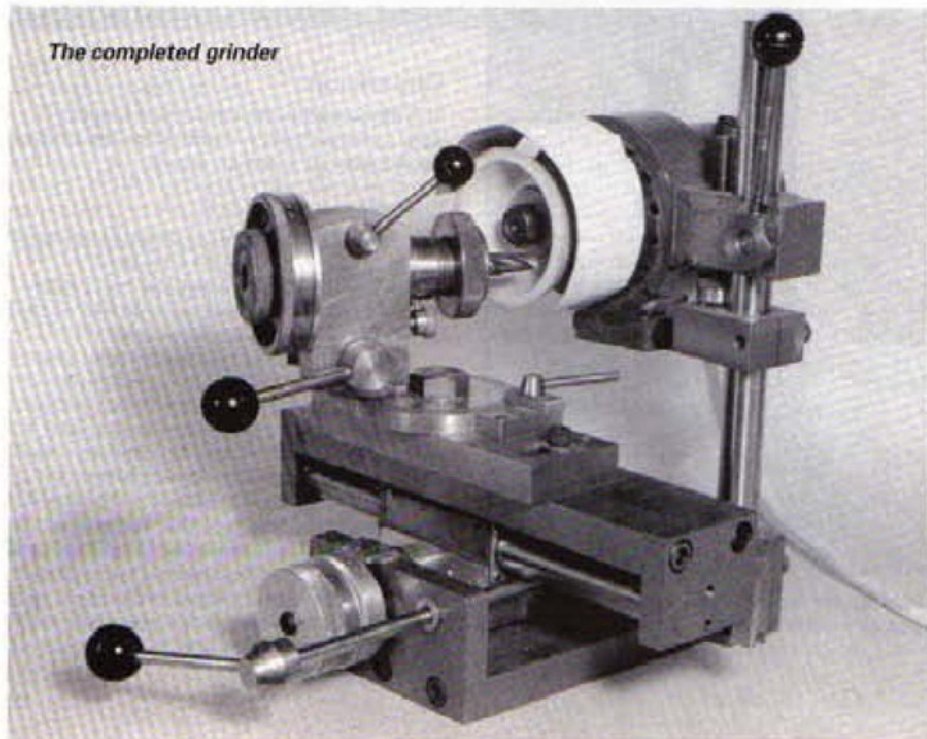


GENERAL ARRANGEMENT

A TOOL AND CUTTER GRINDER

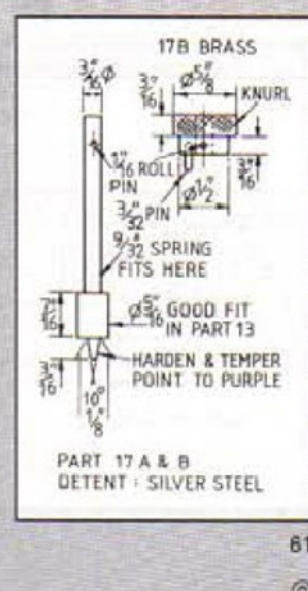
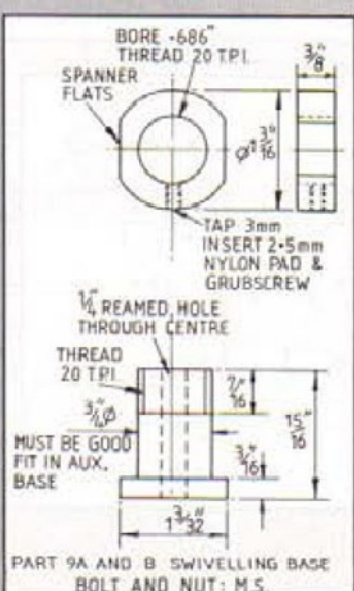
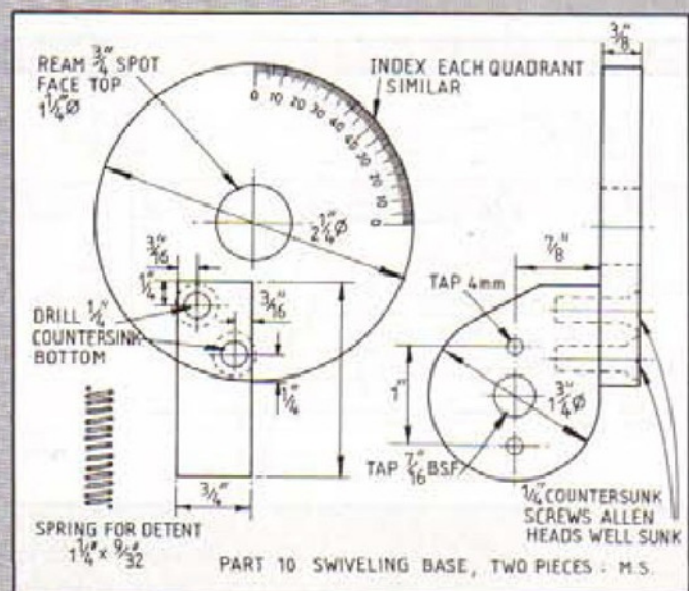
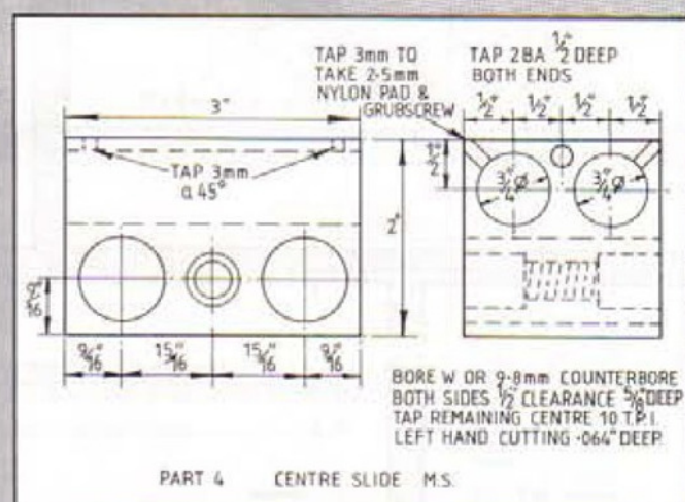
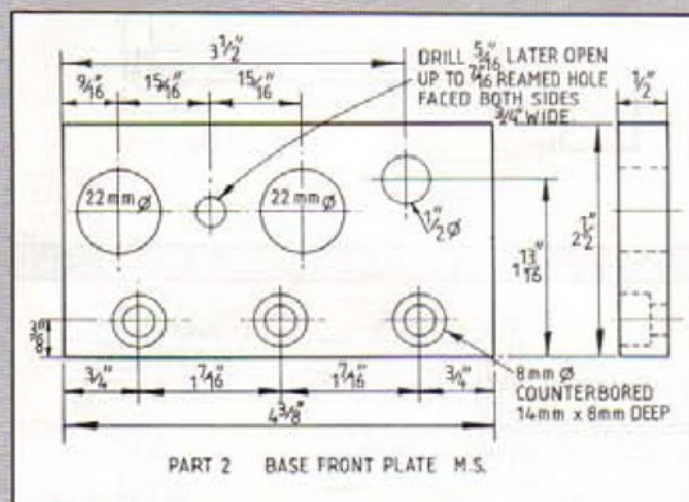
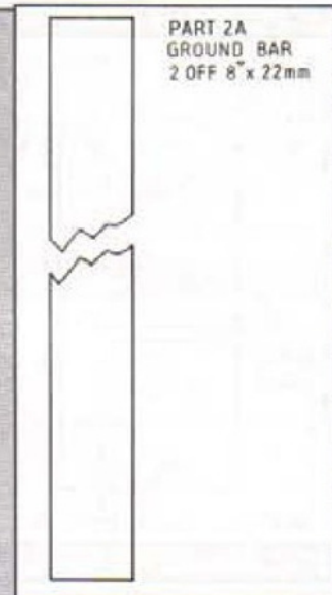
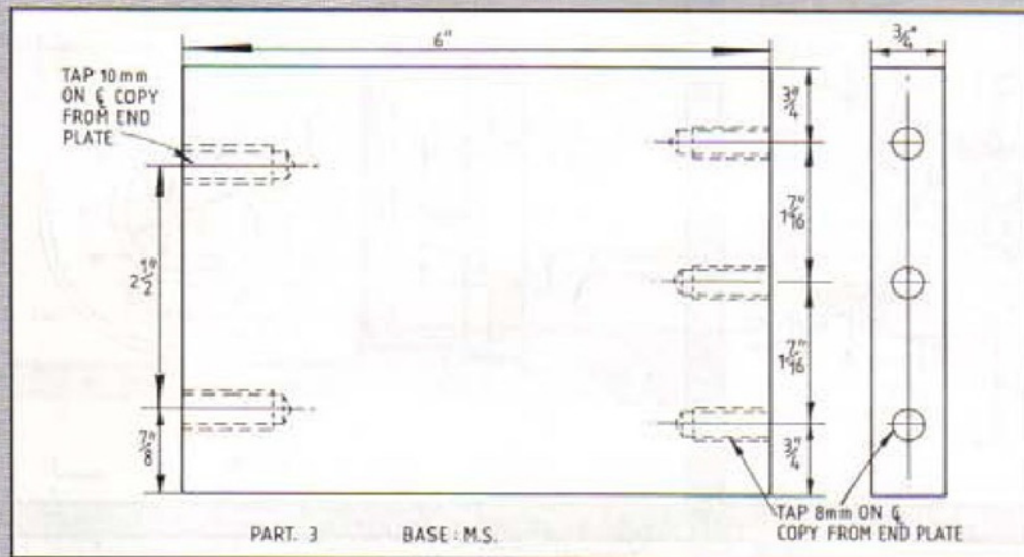
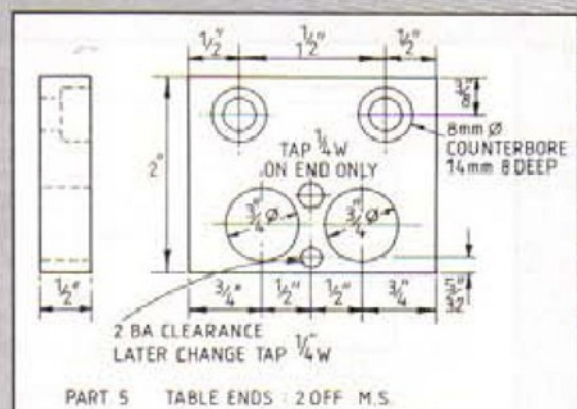
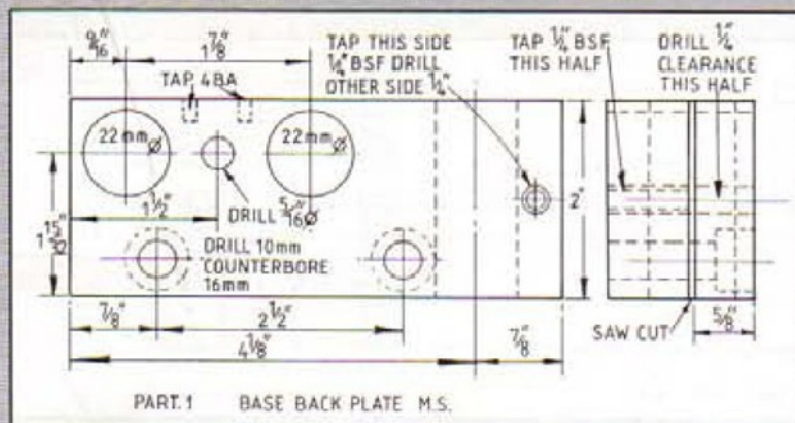
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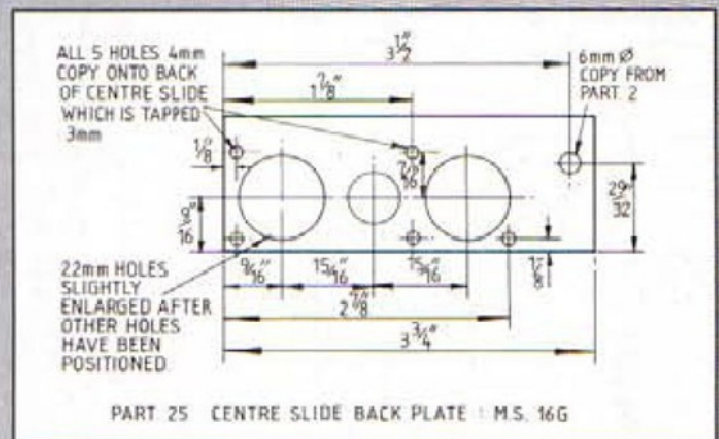
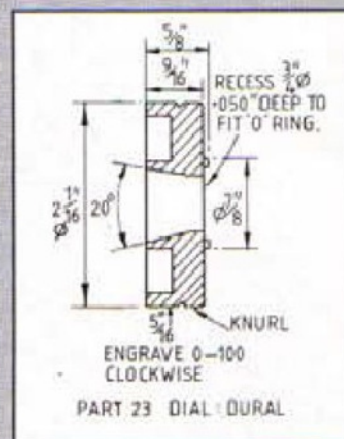
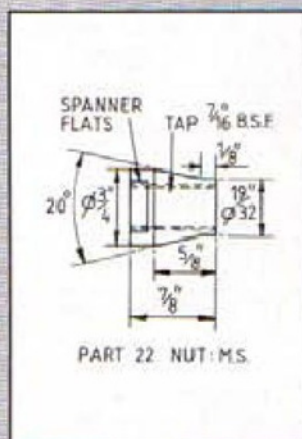
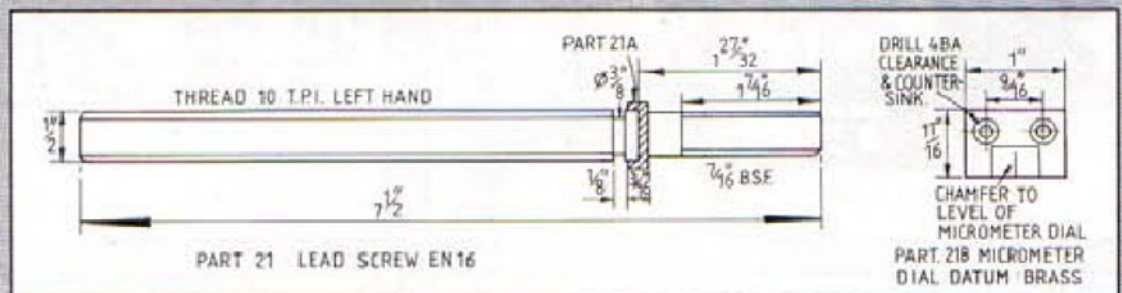
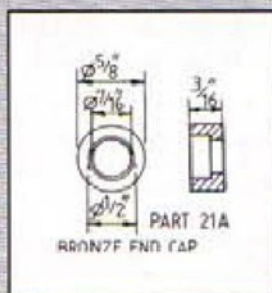
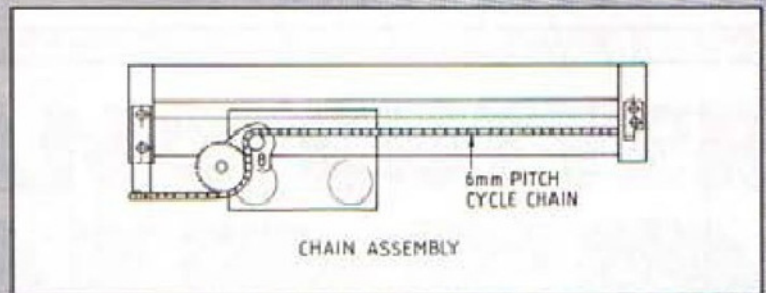
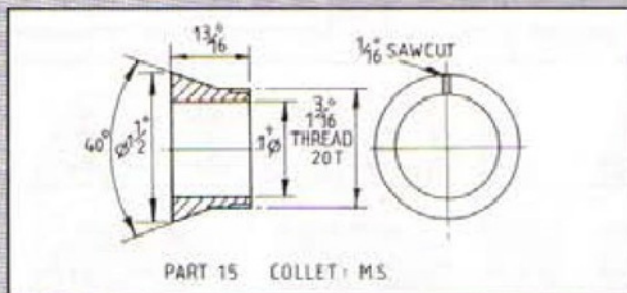
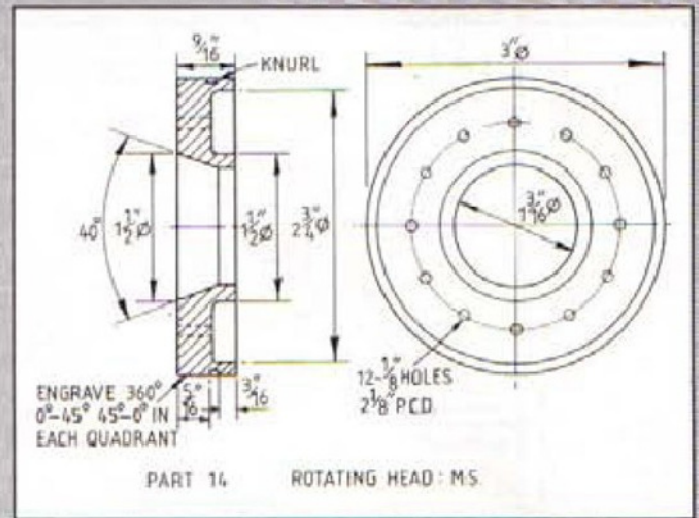
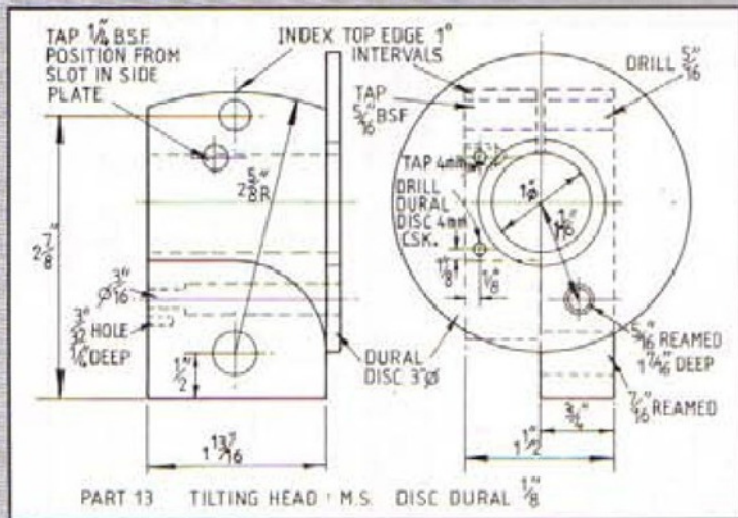
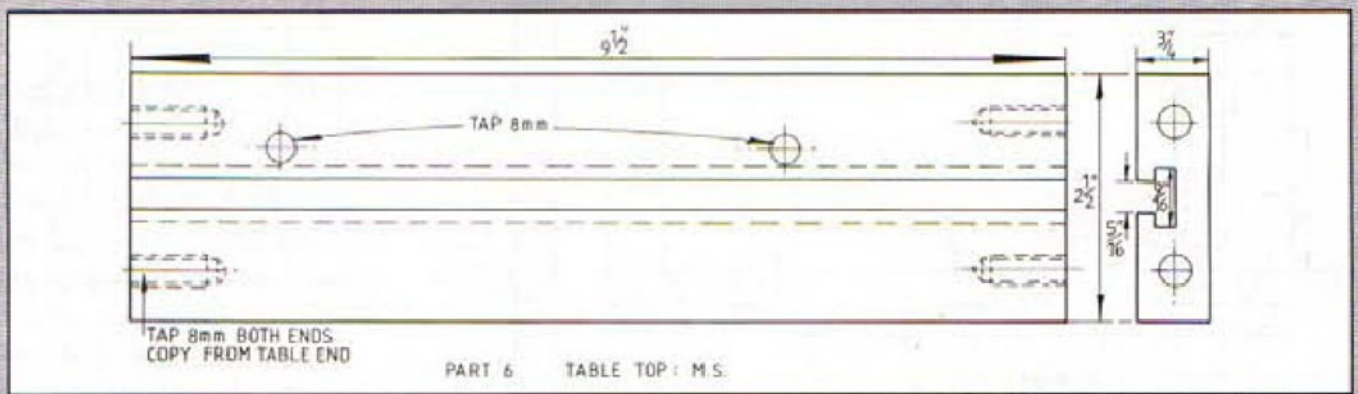
The completed grinder

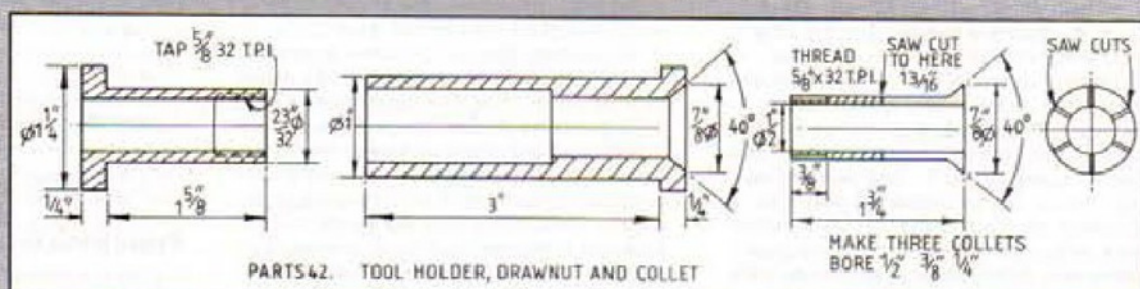
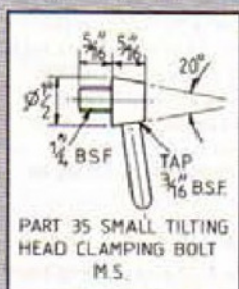
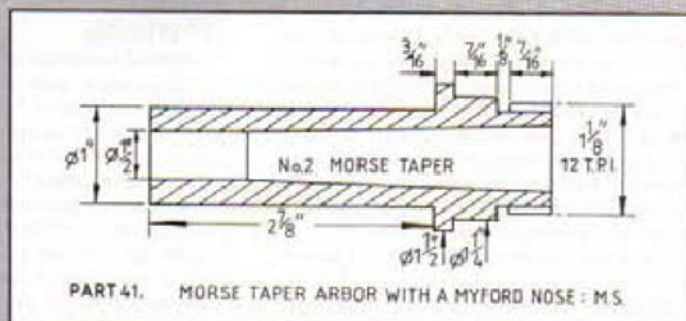
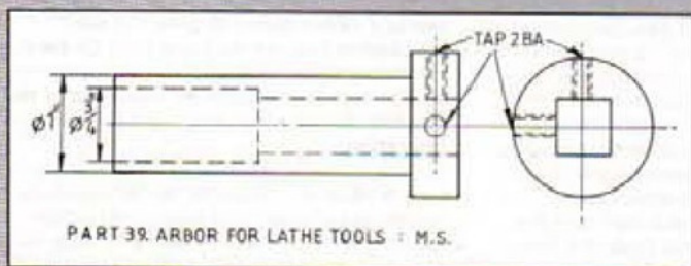
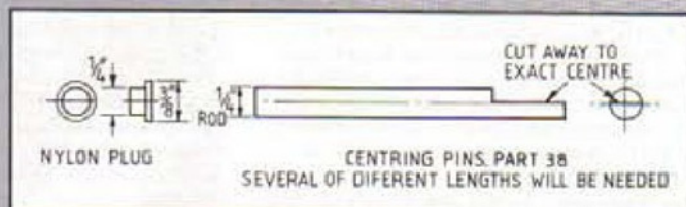
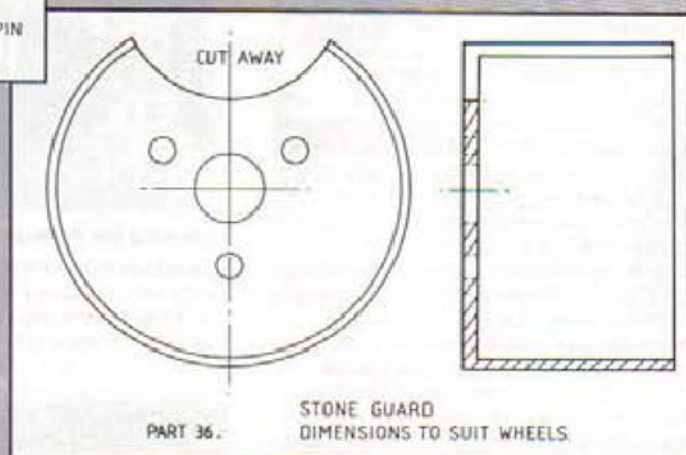
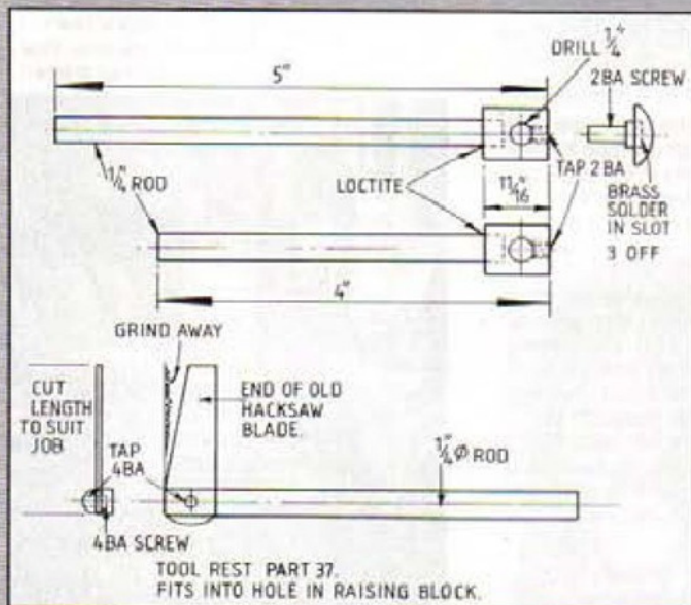
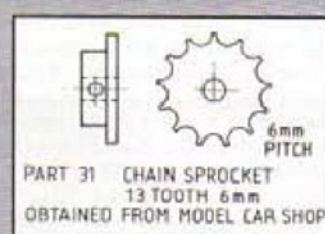
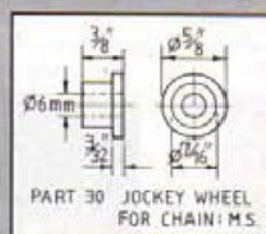
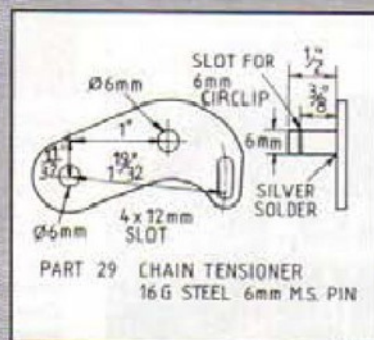
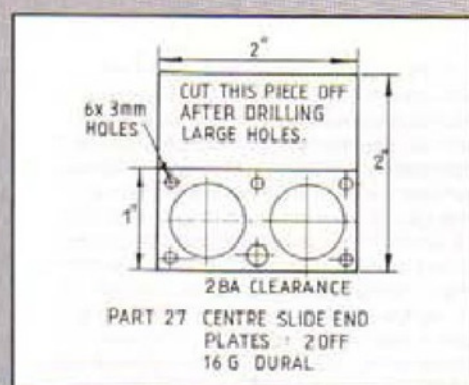
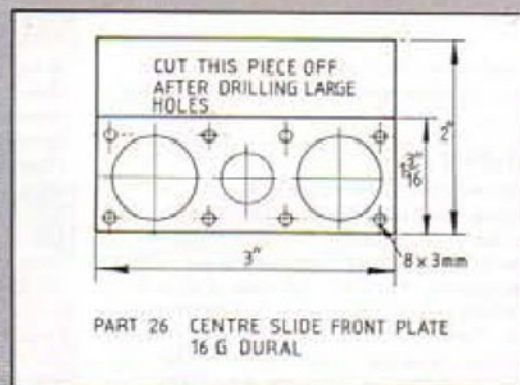
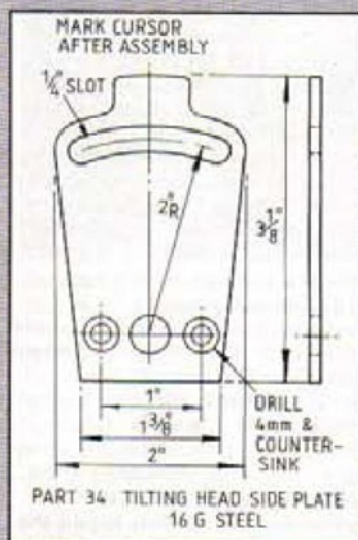
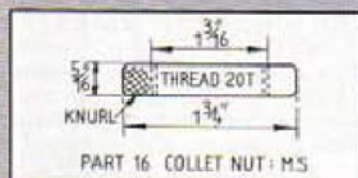


Method

The heart of the machine is the centre slide Part 4. Start by making a sandwich from Parts 5, 27, 4, the other 27 and 5 in that order. After drilling Parts 5 and 27 they are fastened to each end of Part 4 with a 28A cap screw. Both parts 5 are inverted. The sandwich is clamped to the cross slide of the lathe, packing to the correct height. The optical centre finder previously described in this magazine is a very useful tool for this (*Issue 1 page 46*). The longest side should be parallel to the lathe ways, and set true with a D.T.I. (dial test indicator). An engineers clamp should be used to assist the 28A screws to hold the sandwich together. Start drilling with a small drill in the chuck. When drilling from the chuck it is better to push the work through with the tailstock rather than the saddle, placing a block of wood between the job and the tailstock. Increase the drill size until you have a $\frac{1}{16}$ in. dia. hole. Then change to a boring bar.







I use a boring bar between centres turned with a carrier. It is then easy to remove and replace when checking size with the appropriate bar as a plug gauge. Bore until it is a perfect fit, it is important that you have no slack. Move the cross slide over by the correct amount and bore the second hole. If your cross slide has a locking screw on the gib it should be locked while boring. Adjusting the tool in the boring bar to get the correct is a bit tedious. I use a second boring bar to bring me almost up to size and use the previously set bar to make the finishing cut. Boring bars are easy enough to make, simply drill centre holes in each end of a length of round steel bar, and a hole in the centre at right angles with a grub screw to lock the cutter in place. The next job is not quite so simple. First drill $\frac{1}{16}$ in. dia. holes in Parts 1, 26, 4, 25 and 2 in the place that will eventually take the lead screw. Bolt this new sandwich together with a $\frac{1}{8}$ in. bolt. This is once again clamped to the cross slide at the correct height. The fiddly bit is to get packings of the right height under each piece. A $\frac{1}{16}$ in. bar is slotted through one of the previously drilled holes. With a D.T.I. the bar is checked to a level and square to the lathe bed. Paper packings can make all the difference. Once again a clamp is used to help hold the pieces together. Drill and bore the 22mm holes in the correct positions. Place two large bolts through these holes with washers at each end and tighten. The $\frac{1}{16}$ in. bolt can then be removed and the hole opened up to 9.8mm ready for tapping $\frac{1}{16}$ in. L.H.x10T.P.I. This done with the job clamped to the faceplate. It is not necessary to thread the block all the way through, about a third of its width at each end can be relieved to $\frac{1}{16}$ in. clearance size. The four 3mm grub screws and pads fitted at 45 deg. in the top corners of part 4 are there because I got my $\frac{1}{16}$ in. holes very slightly too large. These screws take up the rock. They also stiffen the lateral movement.

When fitting the base (part 3) and table (part 6) parts together the best way is to drill the end plates first with a tapping size drill. Copy the first hole through to the end of the base plate. Tap this hole and open the hole in the end plate to clearance size and fasten both parts together with a screw. The other holes can then be copied through and tapped. Any slight error in the placement of the table top will be rectified as follows: With the table, bars and end plates all screwed together the whole piece is clamped to the milling machine table. Clamp by the bars with parallels under them. Set true to the direction of travel with a clock and flycut to give a good surface. The Tee slot not yet included in the original can be cut at the same setting. Cut a $\frac{1}{16}$ in. slot first and then form the Tee with a Tee slot cutter.

Because it is probable that most people will not have large reamers it is better to bore the tilting head Part 13 with a boring bar. It is important that the 1in. dia. hole is accurately cut as it has to take several different mandrels. The $\frac{1}{16}$ in. dia. hole at the bottom is drilled and reamed after bolting to the face plate. At the same time the top edge is turned to 2 $\frac{1}{16}$ in. radius. The engraving should be done at this setting, this process will be described later. The bottom is also turned out $\frac{1}{16}$ in. plus radius down to exactly the centre line, the front corner was milled away later. The hole for the detent (parts 17A and B) should be

reamed or sized with a 'D' bit made from the same silver steel as used for the detent.

Rotating head

The sequence for making Part 14, rotating head is as follows: Grip the outside of a 3in. plus disc with the jaws reversed. Face the side and turn the $\frac{1}{16}$ in. wide $\frac{1}{16}$ in. deep groove. Turn the part over and grip on the inside of the groove by opening the jaws. Turn the disc down to $\frac{1}{16}$ in. thick and clean up the edge to dia. then bore the 1 $\frac{1}{16}$ in. hole. Set the top slide over 20 deg. and bore the taper. The tool must be at exactly centre height or the sides of the taper will be curved. Do not alter the top slide setting until the collet has been made.



Marking the lines on the micrometer dial.

To return to the rotating head. We come to indexing. I have a peculiar dividing head and had to drill extra holes in the plate to get 360 degrees. It is possible but very difficult to do this operation with a 60 tooth wheel and detent going round 6 times. The accuracy would be poor.

It is also possible to divide with gears, as Professor Chaddock states in his book on the *Quorn* grinder. Make a 60 hole brass plate using a 60 tooth wheel and detent. This plate is pinned to a 20 tooth gear and placed on the second stud the first has 40/20 wheels and the mandrel has a 60 tooth wheel. A stop pin is made to engage in the holes in the brass plate. Each hole will allow the mandrel to turn through 1 degree.

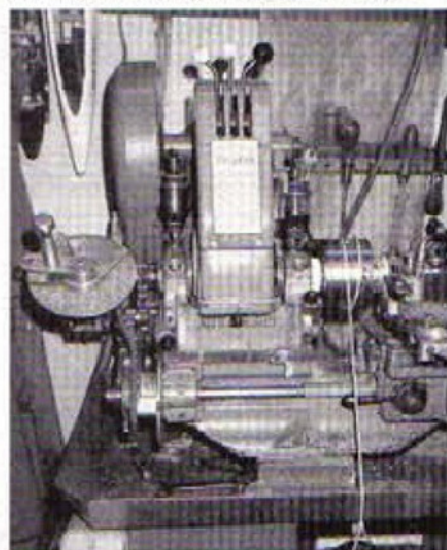
Engraving

Whichever way you choose, the dreaded backlash has to be eliminated. To do this make more than a full turn round the chuck with a stout cord and tie it to one jaw. The other end of the cord hangs down the front of the lathe with a heavy weight attached. A tool with a point more acute than a screw cutting tool is placed horizontally in the toolholder. Make sure that the tool is fastened tightly in the tool holder and the holder is tight on the cross slide. A 0.008in. deep scratch can now be made on the edge of the job by traversing the saddle. Different lengths of mark are needed. Every fifth mark is longer than the others. Every tenth mark is not quite as long as the fifth marks to allow the numbers to be stamped above it. Turn up a centre piece similar to the collet but with a $\frac{1}{16}$ in. dia. hole in the centre. Place the centre piece in the job and bolt to a piece of wood with a $\frac{1}{16}$ in. bolt and large washer. Two strips of wood are also attached to the piece of wood to keep the number punches vertical to the edge of the circle. These pieces should be packed off to

bring the numbers in the right position. One sharp blow with a hammer is all that is needed. Two blows could give you shadow numbers. Mark 0-40 40-0 in each quadrant. Place to one side. Later this piece should be very accurately placed in a four jaw chuck and half a thou skimmed off to remove burrs and raised edges. This produces a very professional finish. While at this setting knurl the remaining piece of edge and make a $\frac{1}{16}$ in. deep groove with a $\frac{1}{16}$ in. wide parting tool. If you have not done engraving before I suggest you do a trial run. Turn the collet next (Part 15). If you want to make two tapered parts fit together, the first should be turned from the front as you already have done. The taper for the collet should be done from the back with the tool inverted. Screwcut the end 20 TPI bore exactly 1in. and part off to length.

Having gained some experience in engraving it would be a good time to make the swivelling base (Part 10). It is important that the edge of the vertical piece is positioned on the centre. It helps if a long line is engraved to facilitate this. This time the marks are running radially so the cross slide is used with the saddle locked. Once again it is numbered 0-40 40-0. Take care skimming this face, it is so easy to take the engraving right off.

The micrometer dial (Part 23) is made in a similar way to the rotating head. The numbers this time are 0-99 clockwise. The knurling is once again done last so that a



Using a heavy object to take out the backlash whilst marking the lines on the micrometer dial. See also the indexing device mounted on the left hand end of the headstock which is being used for this operation.

face is left clean to use for centering when returning to the chuck for skimming. The $\frac{1}{16}$ in.x0.050in. recess is to take a 'O' ring. This is to provide friction drive to turn the dial. The tightness or feel for zeroing can be adjusted by removing metal from the back of the hand wheel. If it is too tight take a bit off the flat. If it is too slack take a bit off the $\frac{1}{16}$ in. face. If a $\frac{1}{16}$ in.x $\frac{1}{16}$ in. 'O' ring cannot be obtained get a larger $\frac{1}{16}$ in. one and cut a piece out and rejoin the ends with superglue. It loves sticking rubber as well as fingers.

Protection for the ways

The purpose of Parts 26 and 27 is to hold felt pads in place. Three thicknesses are



Stamping the numbers on the micrometer dial, aided by a simple stamping fixture.

used behind each one. The large holes in these parts as well as those in Part 25 should be enlarged slightly. The type of felt to use is that for soft toys. Its use here is to keep grit out of the ways. Three thicknesses are also placed behind Part 25.

I have used $\frac{1}{16}$ in. BSF studding to adjust the height of the grinding head and $\frac{1}{16}$ in. BSW for the end stops. This is because they are 20 TPI and allow 50 engraved divisions to give 0.001in. movement. The micrometer wheel which raises the grinding head is Loctited onto the end of a piece of studding leaving the point proud.

The chain sprocket (Part 31) was obtained from model car parts. It is a 13 tooth 6mm pitch wheel. The pin on the chain adjuster (Part 29) is silver soldered in and has a groove to take a circlip to hold the jockey wheel on. The jockey wheel (Part 30) does not need teeth it just rides between the chain sides and over the rollers.

The mandrel (Part 41) that I use for circular tools is the same as the nose on a Myford lathe because I have the collets, if you don't possess these you will have to make the other mandrel (Part 42). The square hole in the lathe tool holder (Part 39) was cut for me by a friend using a wire eroder. A square hole can be made two other ways. One is to drill a $\frac{1}{8}$ in. dia. hole and broach the corners out. The other way is to mill a $\frac{1}{8}$ in. wide slot $\frac{1}{16}$ in. deep in a 1in. bar and braze a $\frac{1}{8}$ in. x $\frac{1}{16}$ in. piece in the top, forming a square hole then turning the whole down to 1in. diameter.

To drill the 12 holes in the rotating head (Part 14) make a brass ferrule $\frac{1}{8}$ in. O.D. $\frac{1}{16}$ in. I.D. Put this in the hole where the detent will fit. Put an arbor in the 1in. hole, lock the rotating head onto the arbor. Rotate the head until a zero comes onto a mark you have previously made in the centre of the top edge of the dural disc. Lock the rotating head with the pinch bolt and drill with a $\frac{1}{16}$ in. drill through the brass ferrule. Slacken the pinch bolt and rotate 30 deg., lock pinch bolt and drill again. Repeat until all 12 holes have been bored.

Powering the tool

The motor is one I had to hand. It is a Stanley portable tool room grinder and has a $\frac{1}{4}$ in. chuck at one end. It was obviously made to take small grinding points. Its speed reflects this about 11,000 rpm, far too fast for grinding wheels. Because it is a brush motor I am able to reduce its speed simply by placing a light dimmer switch in series with one mains lead. To adjust the

speed I used two chalk marks on a disc and measured it with my model engine tachometer. I set it to run at 5,500 rpm and removed the knob so that the setting could not be increased to danger point. Another necessary modification has to be a reversing switch. A cutter grinder has to be capable of running in both directions. I am not entirely satisfied with the motor, it does not have quite enough power, although it is adequate, if you only take light cuts, less than 0.001in. I will be making a belt driven spindle in the future. I will pass on the design. The stone guard (Part 36) was made from a lawnmower clutch, this was not finished when the photographs were taken (neither is it the one seen on the front cover Ed).

The tool rest (Part 37) is the cheapest part, made from a broken hacksaw blade with the teeth ground off. This is a disposable part as it gets ground with the wheel on occasions. The end width sometimes needs adjusting and bending may be required to get into some teeth.

When fixing levers onto pinch bolts make sure when in tightened position they are out of the way. It is worth noting that only an eighth of a turn is sufficient to slacken the grip.

Several lengths of centring pins (Part 38) will be needed, they are lengths of $\frac{1}{16}$ in. silver steel rod reduced to exactly half diameter part way down. These can be hardened and tempered to blue.

A diamond stone dresser is also a must. It is possible to use the carborundum type but not easy to mount. It can be useful though to form shaped wheels for special jobs. It should be rested on a suitable tool rest.

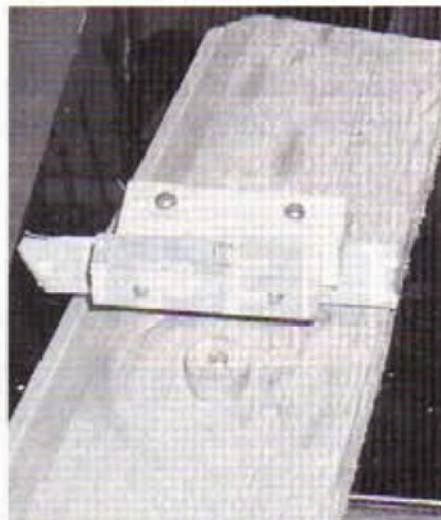


The completed parts for the work head.

Assembly

The two 22mm bars (Parts 2A) are Loctited into the base backplate Part 1 and the base plate is screwed to this part with two 10mm capscrews. Take 3 thicknesses of felt and mark holes on them with a ballpoint pen, using Part 25 as a template cut round the inside of the marks with scissors, this will make the felt tight on the bars. The hole for the lead screw should be about $\frac{1}{16}$ in. Holes for the fixing screws should be punched through the felt. Slip Part 25, 3 layers of felt and Part 4 onto the bars and screw together. Follow with 3 layers of felt and Part 26. Place part (the one with the central $\frac{1}{16}$ in. threaded hole) on the right hand side of the table. Complete the table with felt pads and Parts 27 as previously described. The front base plate and table end can now be fitted but do not Loctite. I have not drawn the positions of

the chain anchors. These will have to be positioned after assembly. Keep the chain ends level with the top and the bottom of the sprocket. The 10BA screws are the largest that will go through the chain holes. They don't carry any weight, they are just to hold the chain in place after it has been placed over the square pins. The lead screw (Part 21) and micrometer fit together as drawn. The nut part 22, is adjusted to give minimum backlash. The hand wheel is tightened right up, adjust the gap if necessary to give correct feel on the dial. The grub screw locks the hand wheel to the shaft. Bolt 9A is Loctited into the Aux. table. The swivelling base is placed on and the nut is tightened to just allow the base to turn. The small nylon pad is popped and

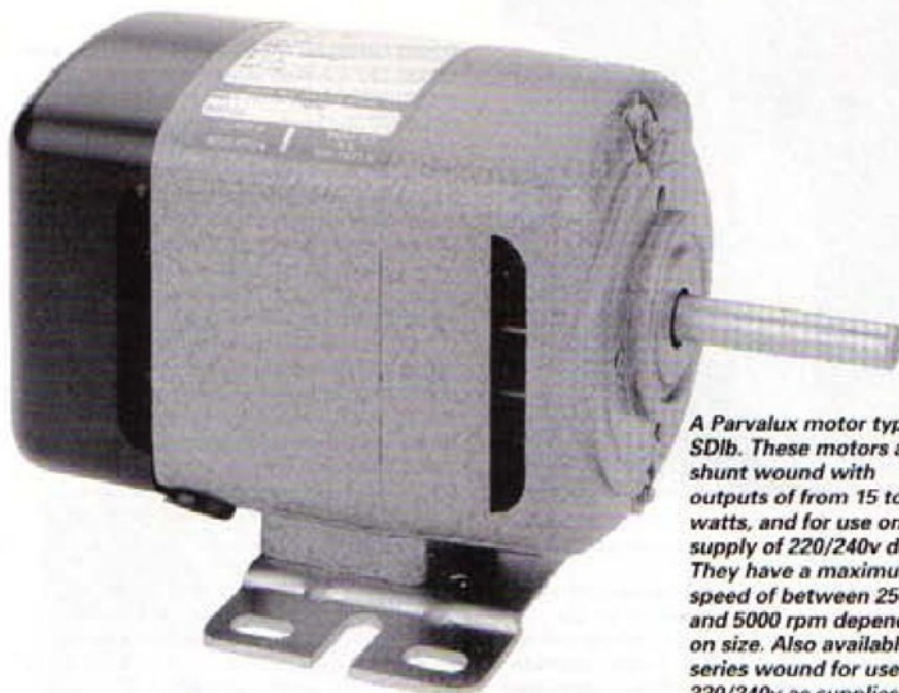


Numbering jig for swivelling base.

the nut is locked in position with the grub screw. The rest of the parts can be positioned from the photographs. The datum marks (except for the rotating head) now need positioning. Place a 1in. bar in the tilting head. Using a D.T.I. adjust the tilt and swivel until there is no deflection on the top and side of the 1in. bar, when the table is moved backwards and forwards with the hand wheel. Lightly mark the datum point. Turn the swivelling base through 90 deg. and check with left and right movements of the traversing lever. If you have drilled part 4 square and your indexing is right there should be no change. Do not use any oil or grease on the machine at all. If you do it will quickly collect carborundum and convert itself into a coarse grinding paste which will wear out the parts. It is a good practice to de-grease all the parts before assembly. I do this with cellulose thinners in a tin. It is amazing the amount of swarf that settles to the bottom after washing. The non ferrous parts can also be washed in hot water with a drop of washing-up liquid in it. When dry they look really pristine. While on the subject of appearance it pays dividends to paint all the non moving parts. Hammerite is a good paint to use, it gives a professional finish and its thick coat is hard wearing and rust protective. You are now ready to give a large slot drill a new lease of life. I will describe how to make full use of your new machine next time. If you do use it now remember grinding is done in small increments 0.001in. at a time, or less. (Drawings not included in this issue will be published in the next, together with details for using the machine).

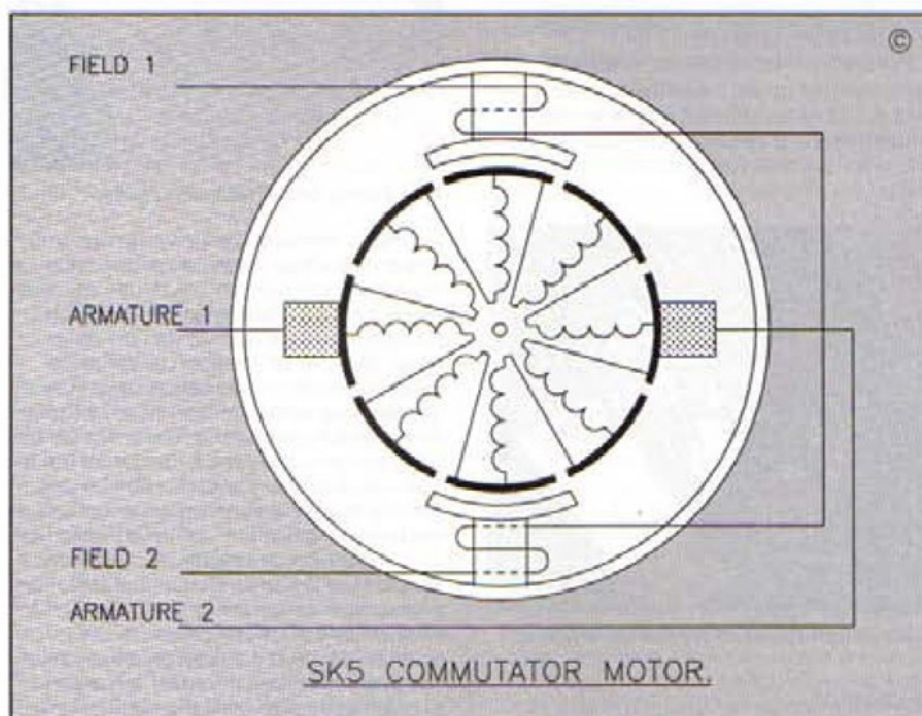
PART 2

In this, the second of our series of four articles on the subject of electric motors and their speed control, the subject of commutator motors, and in particular their use on DC, is being considered. Do read the editor's comments in *On the Editor's Bench* regarding the technical nature of this article



A Parvalux motor type SD1b. These motors are shunt wound with outputs of from 15 to 75 watts, and for use on a supply of 220/240v dc. They have a maximum speed of between 2500 and 5000 rpm depending on size. Also available series wound for use on 220/240v ac supplies.

ELECTRIC MOTORS DC



armature windings are connected. Power is passed to the armature windings by means of spring loaded carbon brushes which rest on the commutator as it rotates, the arrangement being symbolised in **Sk5**.

There are therefore two windings to be connected to the power source which creates two possible configurations, these shown in **sketches 6 and 7**. **Sketch 6** shows the two windings connected in parallel and is called shunt connected, whilst **sketch 7** indicates the windings connected in series and is called series connected.

It would be easy to fall into the trap of considering that these are just two ways of connecting up the same motor. This is not the case as the windings are wound with the appropriate number of turns to suit the intended method of connection. A motor will therefore be made for series, or shunt connection, not both.

To understand the potential for speed variation and motor reversal, a degree of technical explanation follows. This is to be an over simplification of the situation, but should enable readers to understand, and as a result more easily remember, the characteristics of each type of motor.

Two parameters, torque and power, often cause confusion, but should be understood so as to reasonably comprehend the considerations for choice of motor.

Torque

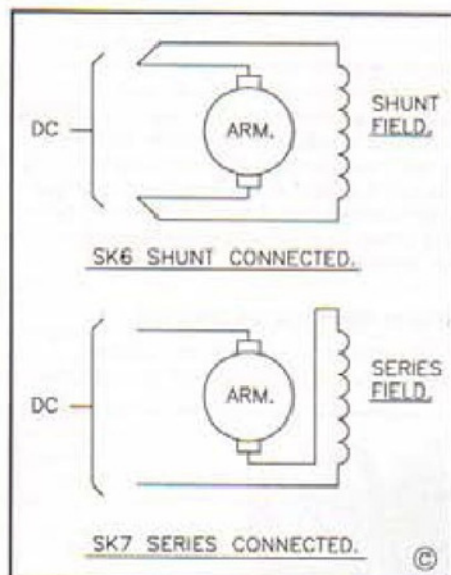
This is the turning force generated by a motor (or any rotary device) and is applicable whatever the motor speed, even stalled. Imagine a drum mounted on a spindle with a crank handle at one end, and a rope with hook wound onto the drum. Place a weight onto the hook and hold the handle still, a force will be required to be applied to the handle to prevent the weight falling. Apply a very small amount of additional force to overcome static friction in the bearing, and wind up the weight

The first part of this series, published in the last issue, covered the subject of AC induction motors, that part should preferably be re-read (see the letter from Jim Cox in *Scribe a Line* elsewhere in this issue re an error in that article - Ed.) prior to reading this part dealing with DC motors. To recap very briefly, a motor consists of two main parts, the rotating and the stationary, these each have their own magnetic field which together react to create rotation. As in the case of the AC motor, the reason why continuous rotation occurs is too complex to attempt to describe in this article. These two assemblies are normally known by different names to those used for AC induction motors, the rotating part being called the armature and the fixed part the field.

DC Commutator motors

The main difference between the induction motor used on AC and described in the last issue, and the DC motors to be described in this, is the method by which power is passed to the rotating component (armature). In the case of the AC induction motor it was explained that power arrives at the rotor by means of a transformer action. It will no doubt be understood that transformers do not work on DC and therefore this method is not appropriate to a DC motor.

For a DC motor, power is passed to the rotating component via a device called a commutator. This is a multi segment copper cylinder which rotates with the armature and to which the ends of the



slowly. It will be found that the force to maintain a steady lifting speed, is substantially equal to that required to hold the weight stationary. This turning force required is called the torque.

Power

Now if the stationary condition is considered, no power is being consumed as the weight is not moving. If the weight is then lifted, power will be used, the amount depending on the distance travelled. If say the weight is moved twice the distance then twice the amount of power would be used.

Motor power

From these two parameters it can be seen that motor power is a product of turning torque and speed of rotation. Consider a motor providing a constant torque, the horse power will drop by a half if the speed is reduced by a half. It is often mistakenly said, "a motor is reduced in speed with no loss in power" when it should say "no loss in torque". In all considerations, it must be remembered that this power is the maximum power the motor can develop, it will of course only develop the power that the driven machine demands.

The basic theory – torque

If two magnets are placed a given distance apart a force will result between them both. Replace the two magnets with two of similar size but weaker, and the resulting force will be found to be reduced. If now the test is carried out using one of each, the result will be a force somewhere between the two previous values.

The force between two magnets can be seen to be dependent on the strength of both magnetic fields. Translating this to a typical motor, the torque developed will be dependent on the magnetic strength of both the field and the armature. Remember this is independent of motor speed.

The maximum strength available from an electro magnet is entirely governed by the type, and amount, of iron and air gaps that make up the magnetic circuit. This value cannot be increased no matter how much current is passed through the windings. Below this limiting value, being in the range that most normal motors would be designed to work, it can be

considered that the strength will be proportional to the number of turns in the winding, and the value of the current flowing through it. In the case of a given motor the number of turns is fixed, therefore the strengths, both armature and field, can be considered to be proportional to the current flowing through each winding. From this it can now be seen that the output torque is proportional to both the field and armature currents.

Considering a situation where the current through one winding is reduced by a half, then the available output torque will be reduced by a half. If the current was reduced by a half through both windings then the available torque would be reduced to 25%. Remember motor speed is still not a factor in these considerations.

The basic theory – speed

What determines the motor speed is a much more difficult situation to understand (and as a result unfortunately also to explain). This will be explained for the shunt connected motor.



Shunt wound motor

For a shunt wound motor, **Sketch 6** shows that both field and armature have the full supply voltage applied to them. The field winding will be wound with a large number of turns of fine wire achieving the required field strength with only a low current. The current being less than an amp for a small motor, and only a few amps for one of many hundreds of horse power.

The armature is though quite different, this will be wound with only a few turns of relatively thick wire, and as a result will have a low resistance to the flow of current. It will have such a low resistance, that if this were the only limiting factor the current would be excessive to a considerable extent. The fact that the motor does not burn out as a result of excess current, is due to a condition known as Back EMF (Electro Motive Force, or otherwise voltage).

Most readers will understand that for electricity to be generated, it requires a wire to move through a magnetic field, this is what happens in the commutator type motor. With the armature rotating, in the magnetic field created by the field winding, a voltage is developed in the armature windings. This voltage is opposite in polarity to that being applied from the power source. As a result of this reverse voltage (back emf) the actual voltage

available to force current through the armature is the difference between these two values. This being only a few volts, the current is acceptably low.

The following figures give an approximation of the value of the back emf. In the case of a motor intended to be fed from a 220 volt supply, this will have a back emf of around 210 volts. This results in the voltage available to force current through the armature, being limited to 10 volts.

Another important factor regarding electricity generated in a wire passing through a magnetic field, is that the voltage developed is proportional to both the speed that it passes through the field and the strength of the field. This means that the voltage developed in the armature is zero when the motor is at rest, and will increase linearly as the motor runs up to top speed.

To expand on this, consider what will happen on start up. In this situation, the back emf will rise as the motor speed rises, until the difference between the the applied voltage and the back emf is just sufficient to force the required current through the armature, to create the required torque. If the speed were to increase further, the

A Parvalux motor type SD1b MB similar to the SD1b but fitted with a single reduction worm gear unit. Available with maximum speed of from 42 to 960 rpm depending on gear ratio.

difference would continue to reduce as would the resulting current, the result would be insufficient torque to drive the machine, it is therefore an impossible condition.

To attempt to put this in a nutshell, the speed of the motor will be that which creates a situation, resulting in the difference between applied voltage and back emf, being just sufficient to establish the current necessary to produce the required torque.

Speed control

Before you proceed to read the rest of this article it will be worth re-reading the article up to this point. It is essential to have a reasonable understanding of what has so far been said, if the following statements of speed control are to be understood.

The following are the essential points to be remembered when considering speed control:-

- 1) The magnetic field created by the field winding (shunt or series) will be proportional to the current flowing through it.
- 2) The magnetic field created by the armature winding will be proportional to the current flowing through it.
- 3) The output torque will be proportional to the product of the field current and the armature current.
- 4) The back emf will be proportional to the product of the shunt field and the speed of rotation of the armature.
- 5) The armature current will be proportional to the difference in applied and back emf.

Speed variations will be of two kinds.

- a) Intentional, arrived at by the use of some form of speed control equipment.
 - b) Unintentional, due to changes in load.
- When using shunt wound motors it is most frequently the case that the field is connected directly to the supply, and is therefore fixed and at its maximum current value. These initial explanations will be based on this arrangement. It is therefore only necessary to consider variations in armature applied voltage and current.

Intentional speed variation

Using the approximate values given earlier, consider a motor running at top speed and full load having an applied voltage of 220 volts and a back emf of 210 volts, that is a difference of 10 volts. Let's assume also that 16 amps is required to develop full load torque.

Now to consider controlled speed variation. This is a case where varying the applied voltage will vary the speed. Do remember that the field is being maintained at a fixed strength and will require a fixed voltage, only the armature voltage being varied. With the motor running at top speed and full load, the condition is that stated above. If now the speed is required to be reduced to 50% but with an unchanged torque demand, the back emf will also reduce to 50%, that is 105 volts. With the motor requiring the same output torque, it will still require to pass a current of 16 amps, and therefore still have a voltage difference of 10 volts to achieve this. The applied voltage will therefore have to be 115 volts. It can be seen that over this range, speed follows very closely to the applied voltage. That is 50% of top speed at 52% of maximum voltage.

Now considering a reduction to 10% of top speed still with full output torque, back emf will fall to 21 volts (210/10) and applied voltage will require to be 31 volts (21+10). In this case, 10% of top speed requires 14% of maximum voltage. Taking this further, consider now the speed being reduced to 2% of top speed the back emf will be 4.2 volts and the applied voltage will have to be 14.2 volts. That is 2% of top speed requires 6.5% of maximum voltage, it can be seen that speed will fall more rapidly

than applied voltage, particularly at lower speeds.

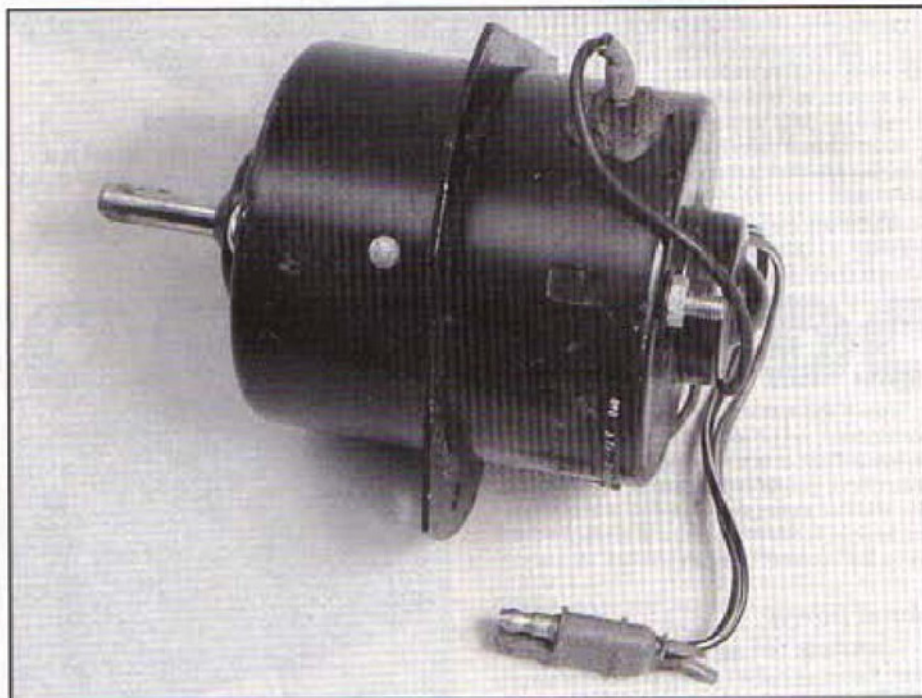
Unintentional speed variations

With the above having been considered for constant torque, let us now consider load variations. If now the load on the motor is reduced (maybe a lathe having finished its cut) and the reduction is to 50% of full load, only 8 amps will now be required to achieve the required torque. As a result of the reduced load the motor will start to speed up. It will continue to do so, until the difference between applied and back emf is just sufficient to establish a

Sophisticated electronic systems can almost eliminate this speed variation by detecting the tendency for the speed to vary, by means of a small generator mounted on the rear of the motor. With this done, it is possible to adjust the applied voltage to automatically minimise the change. To detail this is beyond the scope of this article, and likely to be beyond the acceptable cost for almost all readers of this article.

Shunt field speed control

As an alternative method of speed control, varying the field strength can also



A small permanent magnet field motor for use on 12v, typical of those fitted in many motor cars for cooling fans.

new value of armature current of 8 amps (16x0.5). This will occur when the difference has reduced to 5 volts, being when the back emf has increased to 215 volts.

Remembering that for a fixed field strength, back emf is proportional to speed, it can be seen that it has only increased from 210 to 215 volts. This corresponds to a speed increase of just under 2½% for a variation of 50% in the load, a very stable result. If now we consider the same motor but set to run at 2% of top speed. It was seen above that this situation required a back emf of 4.2 volts and an applied voltage 14.2V. When in this situation the load is reduced to 50%, the back emf would have to raise to 9.2V to create a 5V difference with an armature current of 8 Amps. Again remembering that speed is proportional to back emf, an increase from 4.2V to 9.2V represents an increase to 219% of set speed.

From these examples it can be seen that for a 50% change in load, the change in back emf is in each case a constant, that is 5V. From this it should be apparent that the change in RPM terms is also a constant for a given load change, irrespective of the running speed. It is therefore more significant the lower the set speed, and here lies one of the weaknesses of the system which limits the speed range depending on the variations that can be permitted at the lower speed.

be employed. In this case, the armature has a constant voltage applied and the field strength varied. The reader may be surprised to learn that the speed will increase when the applied voltage to the field is decreased. If the above explanations have been understood, then the reasons for this situation should also not present a problem. Perhaps this is again a case of re-reading what has been said so far before proceeding.

Let us return to our motor with 220v applied voltage and 210v back emf. It was stated earlier in the article that voltage generated in a wire moving through a magnetic field is proportion to magnetic field strength and speed of movement. If now the field voltage is reduced to half so will the field strength. As a result the back emf will reduce from 210v to 105v this considerably increasing the voltage difference, and therefore the current taken by the motor.

As a result of the extra torque available due to the extra current, the motor will accelerate until the back emf has increased back to the level of 210v. Taking note of the statement that back emf is proportional to speed, 210v will again result when the speed has doubled. Therefore it should be apparent that for half field strength the motor will double in speed, that is, inversely proportional to field strength.

It is worth commenting for those who

wish to gain as much from this article as possible, that as output torque is proportional to armature and field currents, that available torque will be reduced in line with the reduction in shunt field current. That is to say, with the motor drawing full load current but with the field at half strength, the available output torque will only be half its normal value. Therefore full torque at twice speed results in no change in output power, this being a product of the two. The motor under these conditions is said to have a constant horse power characteristic. This compares with the case of armature voltage speed control, where horse power output varies proportional to speed, as the available output torque is essentially constant. This is known as a constant torque characteristic.

Another interesting point relates to the loss of the field supply, maybe due to a loose connection. The reader may like to consider at this point what the effect of this will be. If you come up with the correct answer, you have definitely understood the workings of the shunt wound motor. If not, do not be too concerned it is a rather difficult situation to visualise.

If the field becomes disconnected whilst the motor is running, the field will slowly reduce in magnetic field strength over a period of a second or two. The time depending on the size of the motor. Whilst the field strength is decaying, this will have the same effect as the field being reduced deliberately to increase speed.

With a total field loss, the speed will continue to rise in an attempt to maintain the required back emf. As the field will fall to almost zero (there will be a low level of permanent magnetism) the speed will continue to rise in many cases to the eventual destruction of the motor. To what extent this will cause damage, will depend on the circumstances. If the machine being driven is presenting a light load to the motor, it is more probable than if heavily loaded. With a lightly loaded motor it can even happen when starting from rest. Do be extra cautious if testing a motor off load on the bench, taking only a few seconds for this to happen, there is not much time to switch off.

Combined armature and speed control

It would be rare for speed control to be carried out by both armature and field control simultaneously, but not for both methods to be used separately, this will extend the speed range of a motor to its maximum. Typical values for a simple non-electronic control system would be 15:1 armature control and 2:1 field control, making 30:1 in total. It is difficult to be precise as so many factors are involved, but in most cases these ranges could be extended.

Motor cooling fan

Whilst a speed range of up to 30:1 by armature voltage control is stated as practical (and even up to 100:1 with electronic control systems) there is still one factor to be considered. Most DC motors include a fan mounted internally on the end of the spindle to effect adequate cooling. This fan will become less effective as the speed reduces. In the case of applications requiring constant torque output the armature current will remain

largely unchanged, and this being the main source of heat generated in a motor, there will be a high probability of the motor overheating.

To prevent any expensive burnouts the motor must be sized to take this factor into account. This would necessitate a motor more powerful than is required at top speed, so as to ensure that sufficient torque can be permitted when the speed is reduced. As an approximation, over a 10:1 speed range the armature current should be limited to $\frac{1}{2}$ of the maximum at the lower speed, and for 30:1 to $\frac{1}{3}$.

Reversing

In the earlier explanations, regarding the output torque being dependent on the value of the two field strengths, the example of two magnets placed close together was made, but no mention that the force between the two could be either to attract or to repel, depending on the orientation of the magnetic poles.

Taking the example further therefore. When the two magnets are positioned with opposing poles adjacent, then the force will be an attraction between the two. If now both magnets are turned end to end, poles will still be opposite and the force still an attraction. On the other hand, if only one magnet is turned, like poles will be adjacent and the magnets will repel.

This example should clearly indicate the requirement for reversing a commutator type motor. There being two magnetic fields, the motor will continue to run in the same direction if the supply to both armature and shunt field is changed, but will reverse if the supply to one only is reversed. So, in the case of the shunt wound motor, it is possible to reverse the motor by reversing the supply to the shunt field or to the armature individually.

Permanent magnet motors

There are also available motors where the field is derived from a permanent magnet. Its characteristics are all but identical to the shunt wound motor, and I feel this will be clearly understood by the reader. The only difference of substance is that as the field is derived from a permanent magnet it is fixed and cannot therefore be used for speed control. The motor will though exhibit all other characteristics of the shunt wound motor, and speed control by armature voltage control will act in just the same manner. Similarly, reversing the potential of the armature will effect a reversal of rotation.

This type of motor is normally available up to about 150w. Larger motors have been made such as the permanent magnet motors from the failed Sinclair CS, these are still available and a very good buy, they are about 250w (1/3HP) and require a 12v supply. (Obtainable from Bull Electrical, tel. 0273 23077).

Smaller motors

The values quoted for applied voltage and back emf earlier in the article are approximations only. In practice these will vary, even for a given size of motor, depending on many factors, there is however a trend in the way these values differ with changes in size.

The values given are typical for larger, 0.75Kw and above, and higher voltage

motors. For smaller motors and lower voltage motors the back emf is lower in relation to the applied voltage. Again, as a typical value, motors of the type used for various duties on motor cars and intended for 12v are likely to have a back emf of around 10v.

These changes in no way alter the theory of the commutator motor but will alter its characteristics a little, typical of this will be that speed variation due to changes in load will be increased. The smaller the motor and the lower the motor voltage the greater will be this effect in most cases.

Series connected motors

Having explained the basic principles of the shunt wound motor, it remains to attempt to do likewise for its series wound counterpart. This presents a greater problem, both to the author and to the reader. The reason this situation is more complex, is due to both field and armature currents varying simultaneously.

At this point it is worth stating, that if the reader has not grasped a reasonable understanding of the shunt wound motor, there is little point in studying this section. This would leave two possibilities, either to accept that the subject is too complex for the reader (or maybe the author), or to return to the section on the shunt wound motor, until one feels confident about its content. If you consider opting out, do move forward to the conclusions at the end of the article. These recap regarding the outward characteristics of the motor, without the detailed explanations as to why these occur.

In the case of the series motor, shown simply in **Sk7**, both the armature and the field are series connected (i.e. connected in line) hence the name. This means that neither can be considered fixed in value whilst the other is varying, as was the case with the shunt motor.

Speed control

Again variation of speed will result for either of two situations, these being in principle identical to those considered for the shunt motor. Whilst the reason for variation are the same, that is load or applied voltage, the magnitude of the change in speed due to load change is considerably higher. This time the case of unintentional change due to load change will be considered first.

Unintentional speed variation

For the series motor, the statement regarding output torque being proportional to a product of field strength and armature current is still valid. The complication is that these will now vary simultaneously, rather than one or the other as was the case with the shunt wound motor.

Consider a situation where the motor is running at a given speed and at full output torque. If now the torque demanded by the machine drops to 50%, there will not be a 50% drop in armature current as there was for a shunt motor with its fixed field, but a 50% drop in the product of field and armature currents. As both field and armature currents are one and the same, this means that the current will fall to 0.707 times the original current. That is $0.707 \text{ field current} \times 0.707 \text{ armature current} = 0.5 \text{ output torque}$ ($0.707 \times 0.707 = 0.5$), for the rest of this article the figure will be stated as 0.7.

Now, exactly as was the case for the shunt motor, the current passed is as a result of the difference between applied voltage and the back emf developed. In the shunt motor it was considered that for a 220v motor the back emf would be 210v. In the case of a series motor, the difference is likely to be more as the voltage drop through the field has to be considered.

If now a voltage drop through the motor is taken as 20v, this gives a back emf of 200v with 220v applied. Adopting the same principles, the reduction to say 0.7FLC (full load current) would require the volt drop to reduce to 14v and increase the back emf to 206v, and this is correct. It would be easy to assume that the increase from 200v to 206v represents a 3% increase in speed, as it would for a shunt wound motor, this is not so.

The reason for this, is that the motor current is also passing through the field winding and resulting in a field strength reduction to 70% of its previous value. Due to this reduction in field strength back emf will attempt to fall to 140v (200×0.7). This cannot be, as a result it will be necessary for the motor to speed up such that back emf increases from 140v to 206v. This results in a 47% increase in speed, as opposed to the 2½% that resulted with the shunt wound motor when seeing the same 50% reduction in torque requirement.

Here we see the weakness of the series motor for many applications. Consider a hand grinder and running, when grinding, at the correct top speed for the wheel. In this case, as there are no belts or gears normally, the wheel being fitted directly to the motor spindle, the off load demand on the motor will be very low. It is probable that this will be no more than 10% of the full load torque requirement, and in this situation the motor will increase to around twice full load speed. This is totally unacceptable as under no circumstances must a wheel run at an higher speed than recommended. The consequences of a shattered wheel are very frightening. This example highlights the need to use the correct type of motor for the application.

Intentional speed variation

As in the case of the shunt motor, intended speed variation is by varying the applied voltage, the difference being that there is no field that can be varied independently. The same basic situation still stands, that is, for a change in speed but with constant output torque requirement, the motor torque will require to remain unchanged and, as for the shunt motor, the difference in applied voltage and back emf must remain unchanged.

Consider therefore the motor having an applied voltage of 220v and a back emf of 200 volts that is 20v difference. If in this case the motor speed is to reduce to 50% then the back emf will reduce to 100v and with the required 20v difference the applied voltage would have to be 120v. Taking now say a requirement of 2% of top speed the voltage values will be back emf 4v, voltage difference 20v and therefore applied voltage 24v. This is not that different to the situation with the shunt motor, being only slightly less linear.

For the shunt motor, the change in speed due to a change in load, was found to be a constant, irrespective of actual set speed. If considered, the reader should realise that this same situation also applies

in the case of the series wound motor. The major difference being in the extent of the change. It was seen above when considering the effect of a 50% reduction in load, that the speed would raise by 47% of top speed. From this it can be seen that the situation of a motor set to run at 2% of top speed on full load, will increase its speed to 49% of top speed if the load were reduced by 50%, clearly an unacceptable situation.

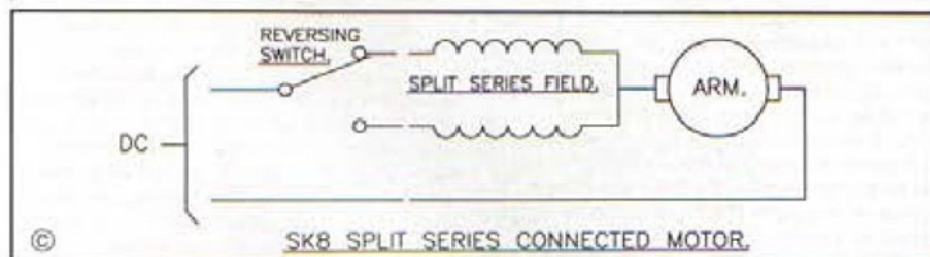
From these examples it can be established that whilst speed control of series motors can be achieved by varying the applied voltage, the speed range over which this is acceptable is very limited. The range will depend on the type of equipment being driven, being wider (say 5:1) for a near constant load such as a fan, and narrower (say 2:1) for a varying load.

Readers may say that speed ranges well in excess of this, are achieved with variable

particularly with the earlier pistol drills. Some readers will be saying, maybe, but the pistol drill is powered by the AC mains and DC motors are being discussed. This is so, but the principles which apply to DC commutator motors can be taken as also applicable to similar AC motors, but more about that later.

Reversing

The principles regarding reversing a shunt wound motor, are equally applicable to the series motor. That is, providing only the field or the armature is reversed all will be OK. In some cases though the motor will be provided with only two leads and reversal will not be possible. Reversing the supply applied to these leads will change both field and armature which, as stated previously, will not effect a change of direction.



speed pistol drills. This is so, but the operator with the speed control trigger in the hand is part of a closed loop, noting changes taking place, and adjusting the trigger to maintain an essentially constant speed. This is rarely practical in other applications.

High output torque

There is one beneficial feature of the series motor, that is its ability to develop high output torque for short periods, say when starting on being momentarily overloaded. It has been stated that it is primarily back emf which limits the motor current, there being only a few volts difference between this and the applied voltage when the motor is up to speed.

When initially starting, or when a sudden increase in load causes the speed to drop, the back emf is below its normal voltage, resulting in a greater difference and therefore a higher motor current. This is no different to the situation which results under similar conditions when using a shunt wound motor, the difference is in the magnitude. The resulting increase in current will in the case of the series motor increase the magnetic strength of both the armature and the field. It will though only increase the armature magnetic strength in the case of the shunt motor, which of course has a fixed field strength.

For the series motor both armature and field magnetic strengths increase and will result in higher output torque under such conditions. The higher torque will be beneficial for such items as fans, which have high starting torque requirements, also pistol drills, where high loads can easily be applied by over ambitious operators applying too much pressure to the drill.

On the other side of the coin though this addition current can easily cause the motor to burn out if the overload is prolonged. I suspect this is something which many will have experienced,

Split series motors

This is a special type of series motor which is specifically intended for reversing applications. It is wound with two series field windings which are arranged as in sketch 8, from this it can be seen that the motor has three terminals. The two windings are wound so as to reverse the field's magnetic polarity when the supply is changed from one terminal to the other.

In all other respects, the motor exhibits the same characteristics as the conventional series motor. They are of course, a little more expensive than the normal series motor. In view of this it would be pointless in purchasing such a motor at its full price, intending to use it for a single direction application. On the other hand, if such a motor became available cheaply, there is no reason why it could not be used for a single direction application, employing only one field winding.

In simpler terms

If, in an attempt to improve the understanding of the commutator motor, and thereby its application also, this article has, of necessity, been too time consuming, the following brief details of their characteristics cover all the important features.

Shunt motor

Speed S1. The speed of a shunt wound motor can be effected by varying the armature applied voltage.

S2. The change in speed will be approximately proportional to change in applied armature voltage. That is, at 10% of maximum volts, speed will be about 10% of top speed.

S3. The change in speed due to change in torque demand is low. See Sk9.

S4. Whilst change in speed due to change in torque demand is low, it is though constant through the speed range.



The major assemblies of a permanent magnet motor, this one having an output of 250 watts at 3000 rpm. It is for use on a 12v supply and has a full load current of 29 amps. Note the absence of windings in the main body and the heavy gauge wire used on the armature. The absence of fan, probably means that the available output will be less affected at lower speeds. The small grooves added at the left hand end of the armature are for balancing purposes.

Therefore a motor, having a top speed of 1500 rpm and a 5% increase in speed from full torque to off load, will increase by 75rpm. If then the speed is reduced to 1/20th of top speed, ie 75rpm, the speed will still rise by 75rpm if the load is removed giving 150rpm. The speed change is therefore more significant at lower speeds.

S5. With a simple controller a speed range of 15:1 is easily achieved. For some applications this speed range could be extended to 30:1 or more.

S6. The above (points S1-5) are when the shunt field is held at constant value.

S7. Additional speed range can be achieved by reducing the value of the shunt field current. In this case the speed increases with reduction of shunt field current.

S8. Speed varies inversely to changes in shunt field current. That is to say, for a reduction to half the maximum shunt field current (at half applied voltage), the speed will double.

S9. By this method a 2:1 speed range is easily achieved, under some condition this may be extended to 3:1 or more.

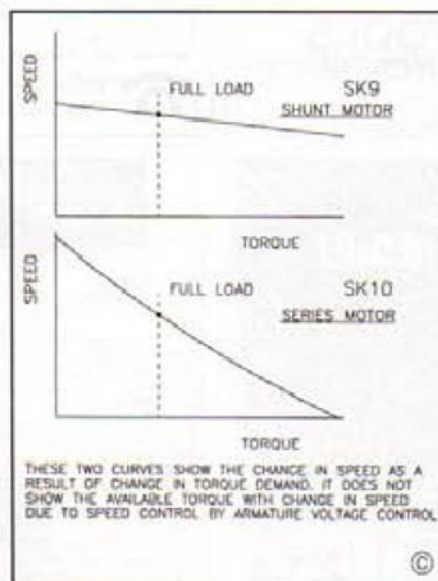
S10. These two methods of control can be applied to the same application, to give between 30:1 and 90:1. The two adjustments would not be applied simultaneously, but it would be normal to raise armature volts prior to reducing field volts.

S11. When applying speed control over a wide speed range, it may be necessary to reduce the rating of the motor

at the lower speed due to the reduced efficiency of the internal cooling fan. Typically by 33% at 1/10 top speed and by 50% at 1/30 of top speed.

Torque. **T1.** Armature current is proportional to output torque (for constant field current). That is, at 50% torque demand armature current will be 50% of full load current, and if overloaded to 150% maximum torque demand the armature current will be 150% of full load current.

T2. Maximum torque available is reduced proportionally to any reduction in field current. Therefore if a motor has its



field reduced to 50% of its normal value to double its speed, then the maximum torque available will be 50% of its normal maximum. For this reason it is normal only to apply shunt field speed control when the armature has full volts applied.

General G1. A motor wound for use shunt connected, cannot be used series connected.

Series motor

Speed SS1. The speed of a series wound motor can be affected by varying the armature applied voltage.

SS2. The change in speed will be approximately proportional to change in applied voltage. That is, at 10% of maximum volts, speed will be about 10% of top speed.

SS3. The change in speed due to change in torque demand is high. See **Sk10**.

SS4. Change in speed due to change in torque demand is constant through the speed range. Due to this, and the fact that it is high, it is impracticable to attempt the speed control of a series motor beyond 5:1, frequently less.

Torque ST1. Armature current reduces at a lower rate than torque demand. Typically at 50% of maximum torque demand the current will be 70% of full load current.

ST2. Series motors can generate a higher output torque than shunt motors during short time overloads, and when starting.

General SG1. In practical terms, it is not possible to use a series motor shunt connected.

AC Commutator motors

It has been briefly mentioned that much of what has been said is also applicable to very similar commutator motors intended for use on AC. This may be true but reference to a well known manufacturer's catalogue of such motors only indicate series motors for use on AC. The fact that they have similarities, an individual motor may not necessarily be usable on either form of supply. The following list what is OK, it would not be wise to go beyond this. A motor having a dual supply indicated on its nameplate is obviously OK on either AC or DC. A motor indicated as for use on DC should only be used on DC. One listed for AC will probably function perfectly on DC, in fact it may be possible to increase its output by 10%.

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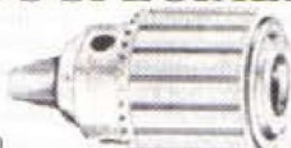
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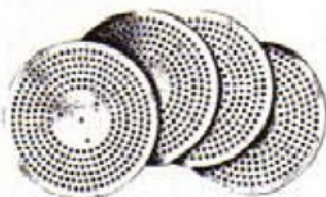
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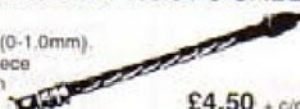
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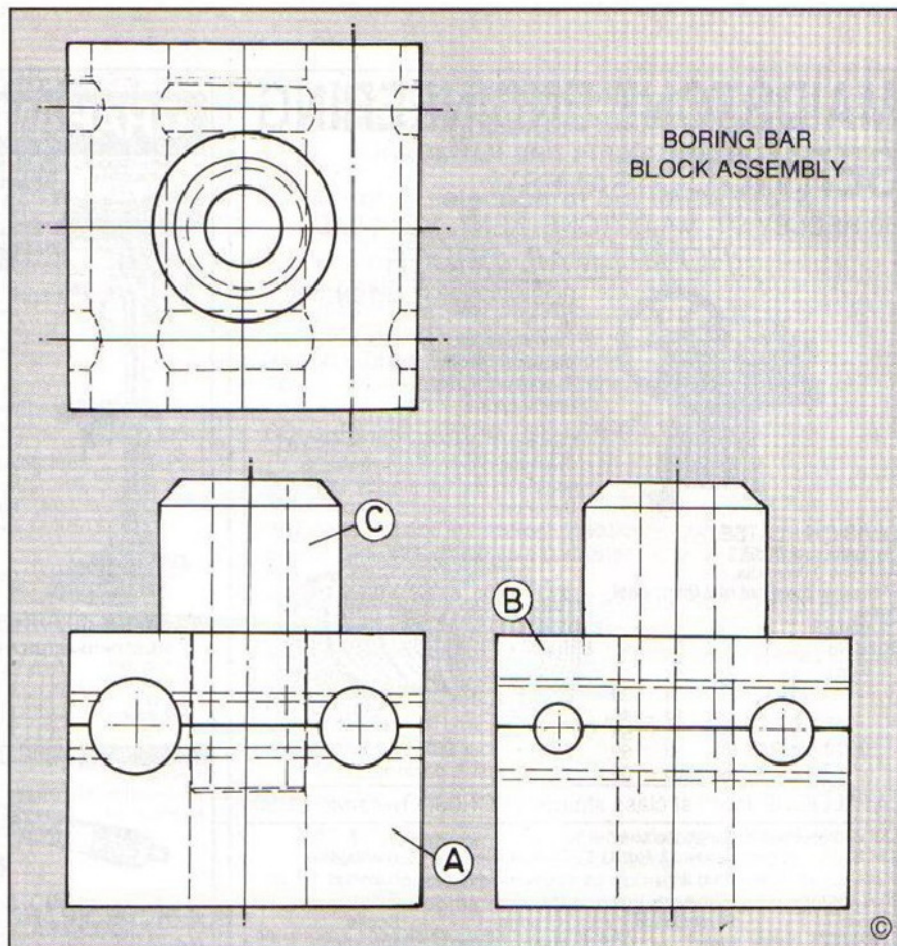
MR S.T. Clark of Frankston, Australia made this boring bar block for his Taiwanese 10BS lathe. It should present very little difficulty to adapt dimensions for other machines.

The versatility of a lathe can be easily improved by adding a boring bar holder to the items, such as a four way tool post (block) etc. which can be clamped to the tool post of many lathes.

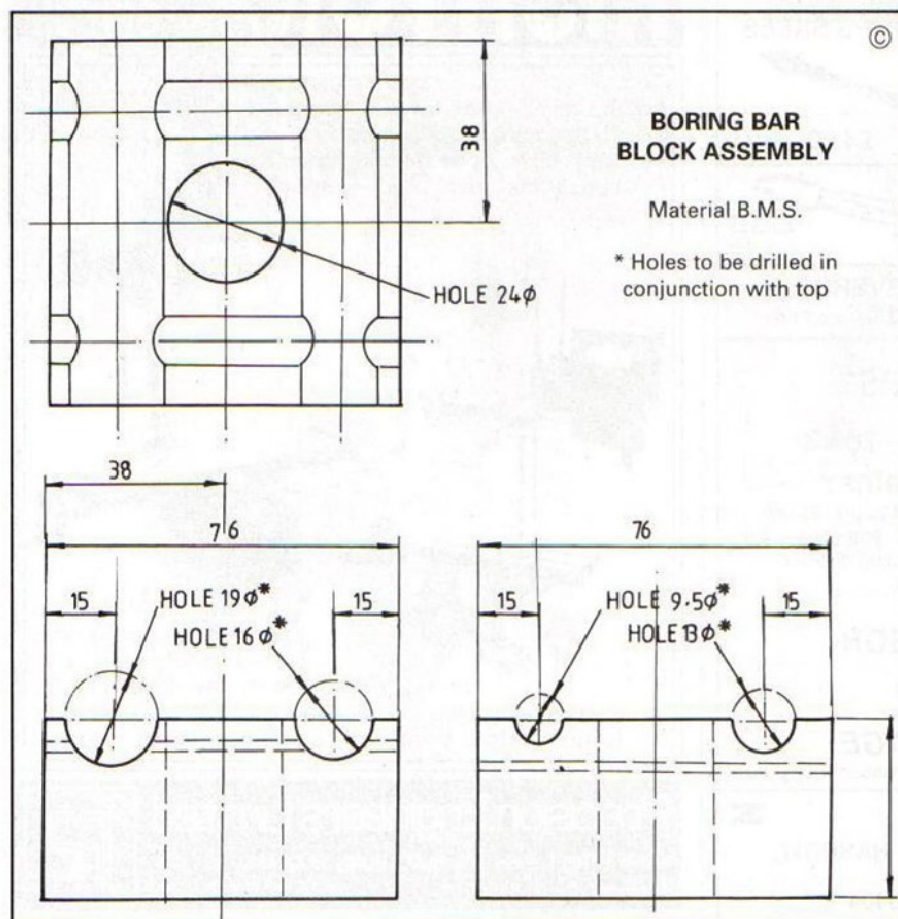
My previous machine, an Australian made 4½ in. CH type bought in 1953, was fitted as standard with a tee slotted cross slide. I drilled a suitable piece of 2in. square bar lengthwise ¾ inch.

A second and shorter piece about ¾ in. long was also drilled and four holes were drilled at right angles across the assembly with adjoining faces at the lathe centre height, the whole lot being held firmly on the cross slide by the tee bolt and nut. This unit could only be used for cross drilling on centre and with a boring bar inserted, parallel boring. Clamping was achieved by machining about 0.01in. off the bottom of the upper section of the tool holder. Then I replaced the old machine by a new Taiwanese 10BS machine, this was described in its handbook as 305 x 584mm or 12in. swing x 23in. BC.

BORING BAR
BLOCK ASSEMBLY



A BORING BAR



I soon realised that, for this machine, the block would need to be made to fit the 76mm wide compound slide, with its top 36mm below centre. I therefore obtained some blocks of BMS bar 80 x 80 x 50mm (A) and 80 x 80 x 25 (B) respectively. Each piece was centred in the four jaw chuck and drilled and bored 24mm dia., the size of the bottom 20mm of the toolpost.

The 50mm piece was reduced in thickness to 36mm and the 25mm piece to 19mm, having cleaned up a reference face on each first.

The hold down peg (c) was now made from a piece of 38mm shafting, turned down to 24mm dia. for a length of 30mm and totalling 65mm overall and then bored 16.2mm to fit the tool post. (So long as the total thickness of all three pieces when fitted together is between 77 and 65mm it will be alright. The item can be made from shorter pieces of 38 & 25mm material, press fitted together if desired.) The whole lot can now be cleaned up and sized to 75mm square. I used woodworkers clamps as well as plugging each successive cross

QUICK TIP

To protect surrounding metal from spatter when electric welding, a light film of machine oil over the surface of the area to be protected will help prevent spatter from sticking. The joint and immediate area must be left clean.

Alan Jeeves

hole with a short piece of material of the correct size and used a shim made from a piece of tinplate to provide the squeeze. Skimming the underside of the upper piece could also be appropriate.

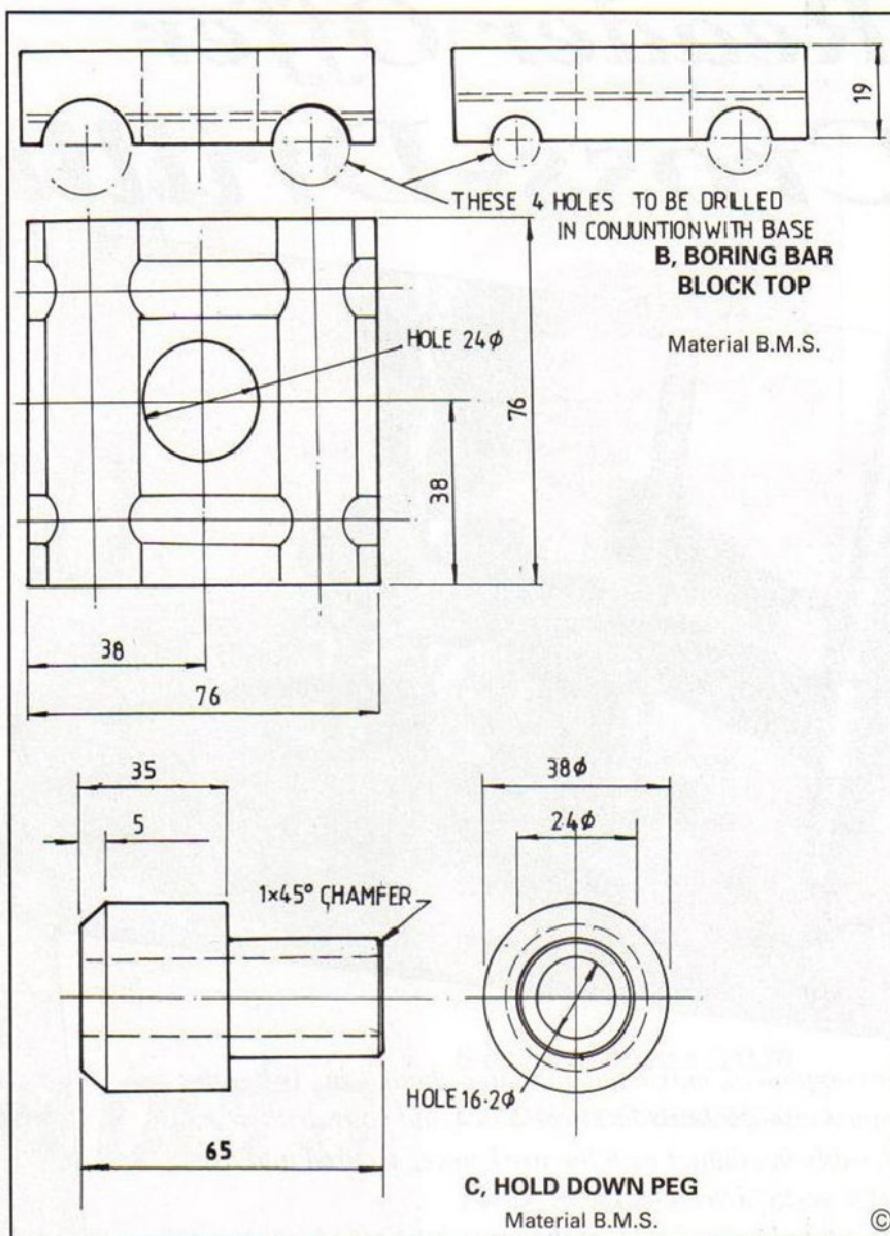
In my case I chose to insert a shim made from a piece of tinplate between parts A & B, made from a piece of a coffee can which was cut to 100mm square. The corners were cut off at 45 deg. a few mm inside the 76mm line leaving a small triangle of about 5mm at each corner. The hold down nut is tightened up so that nothing will move and to be on the safe side I added two woodworkers clamps across the clean faces. Then the holes were drilled, beginning with about 6mm and opening out to size. When the unit was taken apart the tinplate was cut cleanly and there was no evidence of tearing.

The cross hole centres were marked, 15mm in from the finished outer edges and each pair of holes drilled parallel and opened up to the full size decided upon. Each hole was started by using a Slocombe centre drill and with the cross slide locked it was easy to move the saddle out of the way to change drills in the headstock chuck. After each hole was opened out to its correct size a piece of bar of the correct size was inserted to ensure no unwanted movement. After drilling the first pair of holes the hold-down was loosened and the other pair set up to be drilled being careful to ensure that the plugs were not cut through. It only remained to give the

BLOCK

outside faces a final light clean up and reduce the length of the hold down peg, if necessary. Finally make the nut locking handle ensuring that it stops at 4 or 5 o'clock of rotation. The outside finishing cutter I used was the five toothed unit supplied with my Drill-Mill.

The block can be used for a variety of jobs: holding either work or tools, i.e. boring holes on centre boring cylinders or tapers and with the whole assembly inverted one can insert a small tool with its edge on centre for cutting 'O' ring grooves or similar as illustrated on p.36 of *Lathe Accessories* by E.T. Westbury (no longer in



print - Ed.) and p.41 of *Using the Small Lathe*, L.C. Mason (out of print - Ed.).

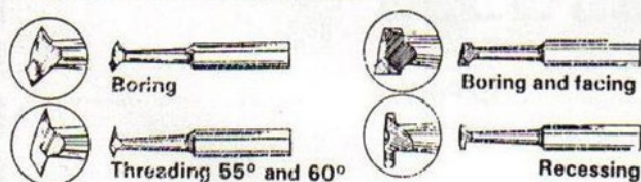
I have used tools made from odd pieces of high carbon steel, gramophone needles 0.062 in. dia. transcription types with the 30 deg. point. Tungsten carbide drill shanks 3.175 x 25mm long which are often thrown away by Printed Circuit Board

manufacturers. These latter shanks can, of course, be used for many other purposes such as 30 deg. points for scribes and 90 deg. points for centre punches. Just ask your nearest PCB maker to "sell" you a few to a handful of his old shanks - He'll probably give you more than you bargain for.

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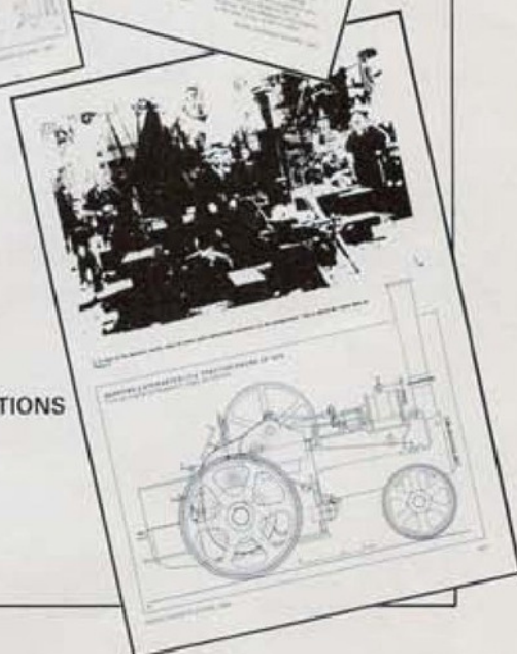
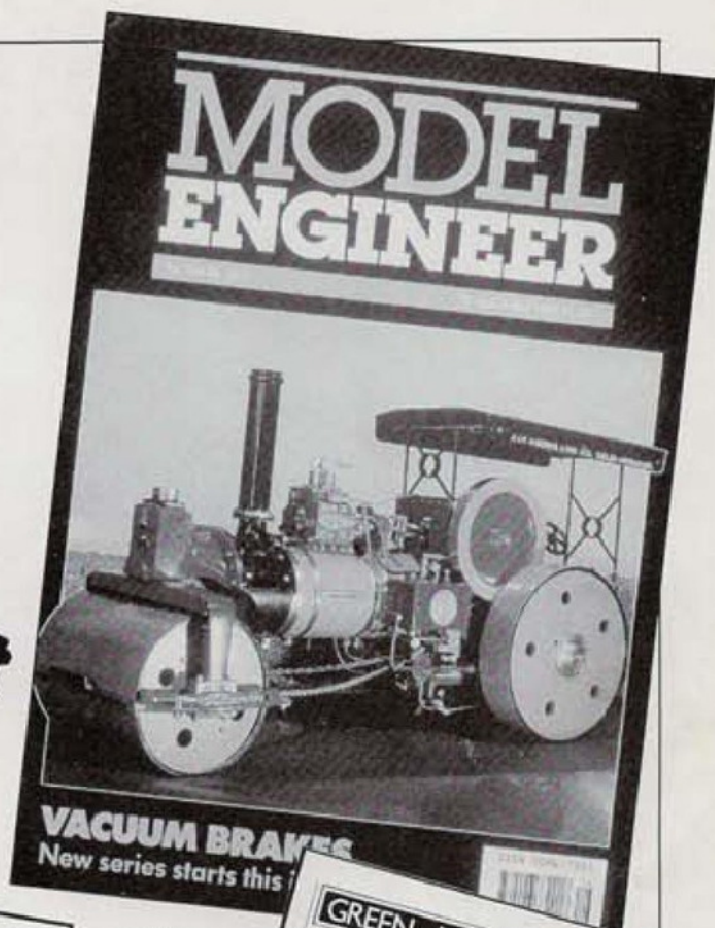
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FORWARD
TO...**
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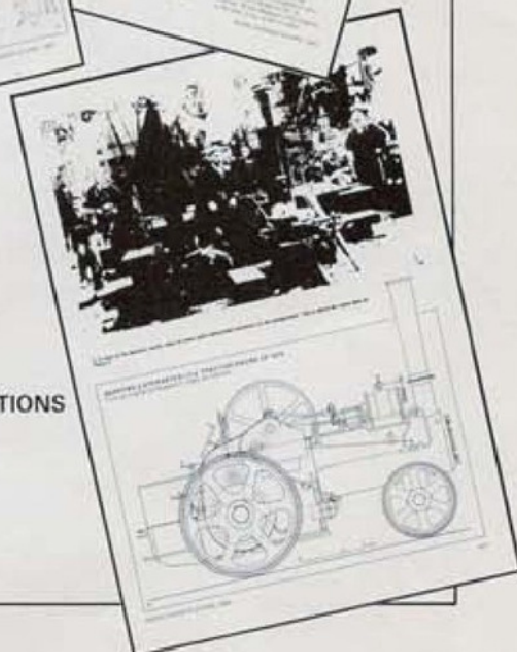
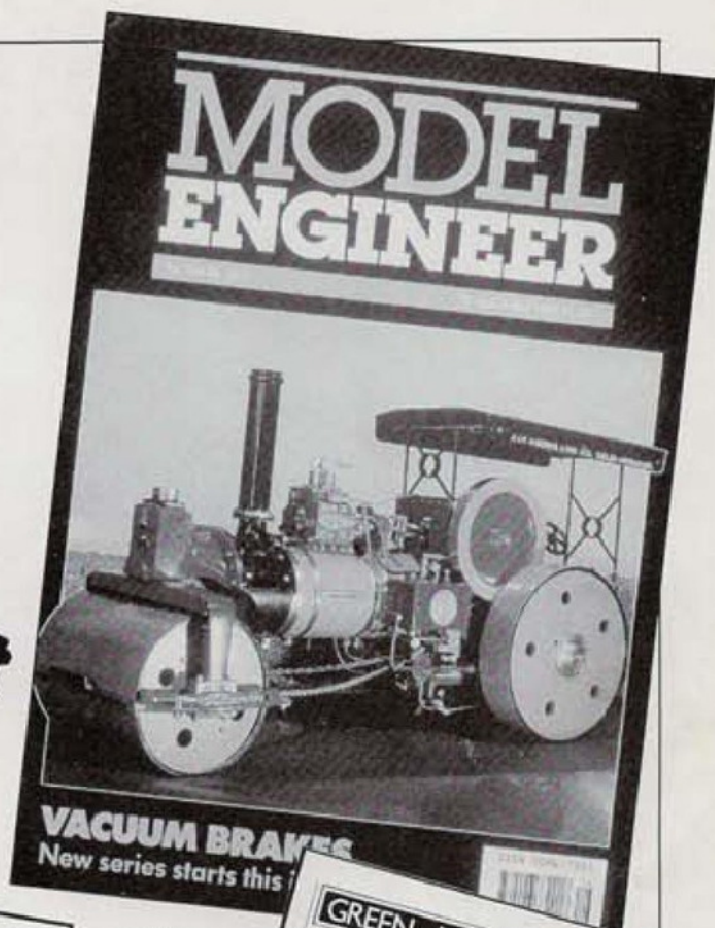


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